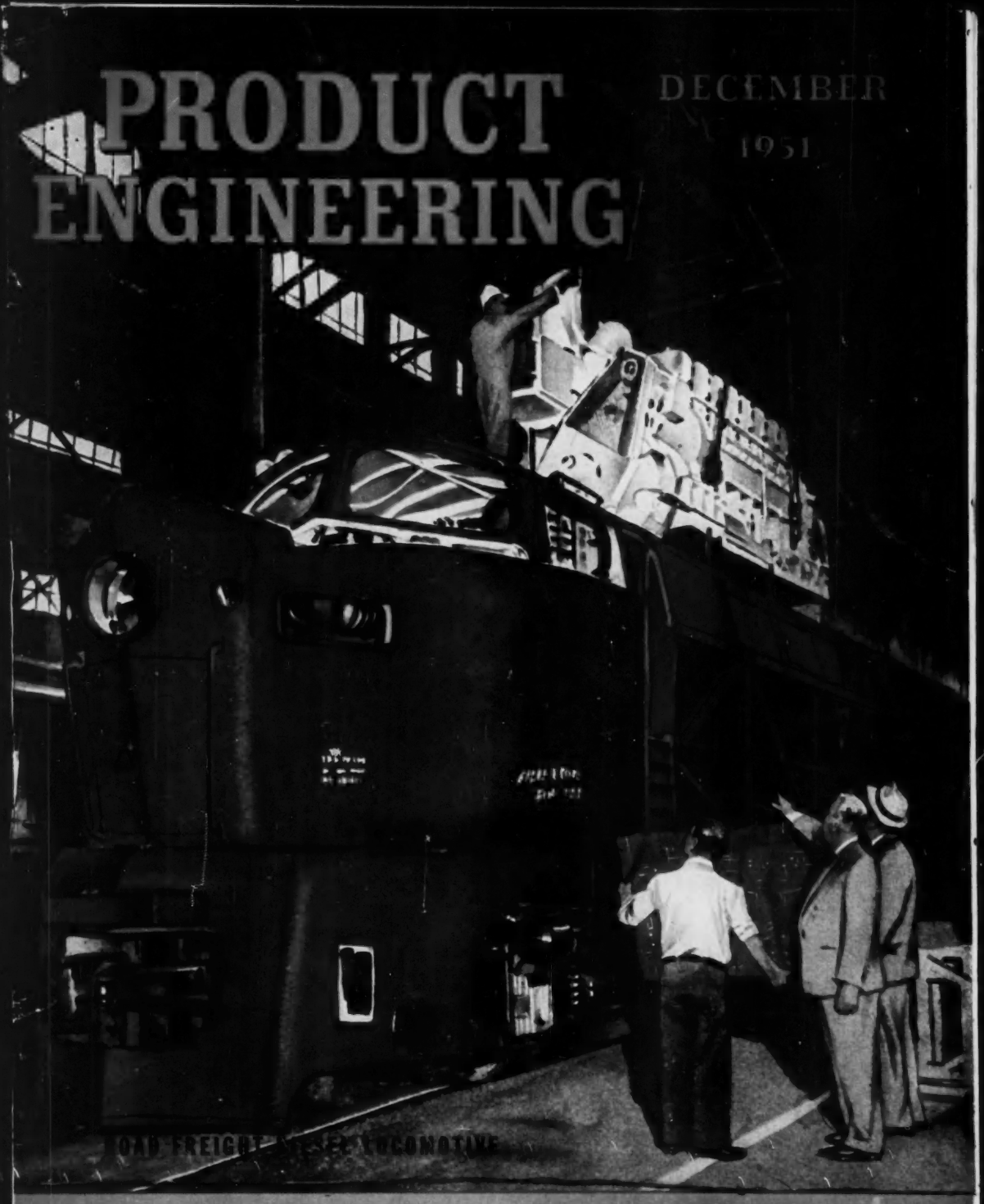
PRODUCT ENGINEERING

DECEMBER 1951



IN THIS ISSUE—Stainless Steel Powder Metal Parts + Organic Coatings + Selecting Fluid Couplings + Backlash in Gears + Integrally Stiffened Aluminum Extrusions

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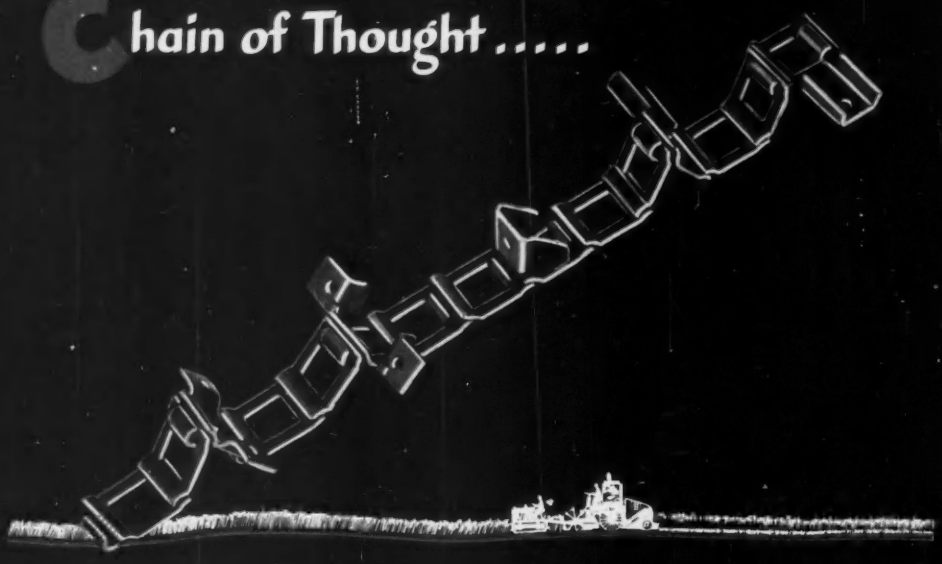
Chain of Thought.....



SHARON* SPECIAL ALLOY ADDS STRENGTH TO FARM IMPLEMENT CHAINS

The chain used on farm implements today is tougher, more rust resistant, easier working and less expensive than ever before. This is a direct result of cooperation between chain makers and the steel industry.

While manufacturers were developing a drive chain that could be produced directly from coils by automatic machinery, mill engineers were working out a stronger, more rust resistant steel that would be applicable to the automatic equipment.

The present farm program has expanded mechanization, demanding greater tonnages of this special chain steel, of which Sharon is one of the leading producers.

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For information on Titanium Developments contact Mallory-Sharon Titanium Corp., Indianapolis 6

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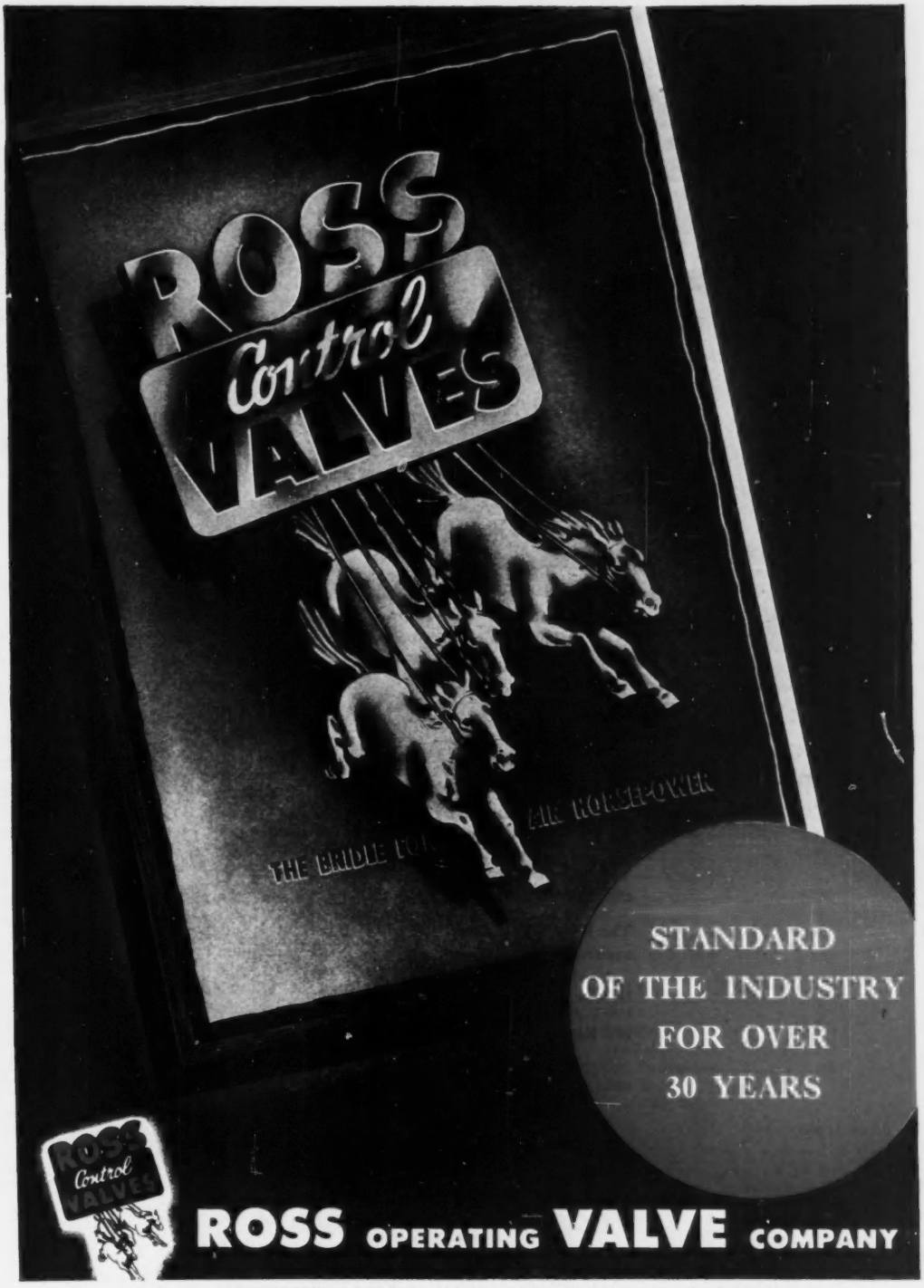
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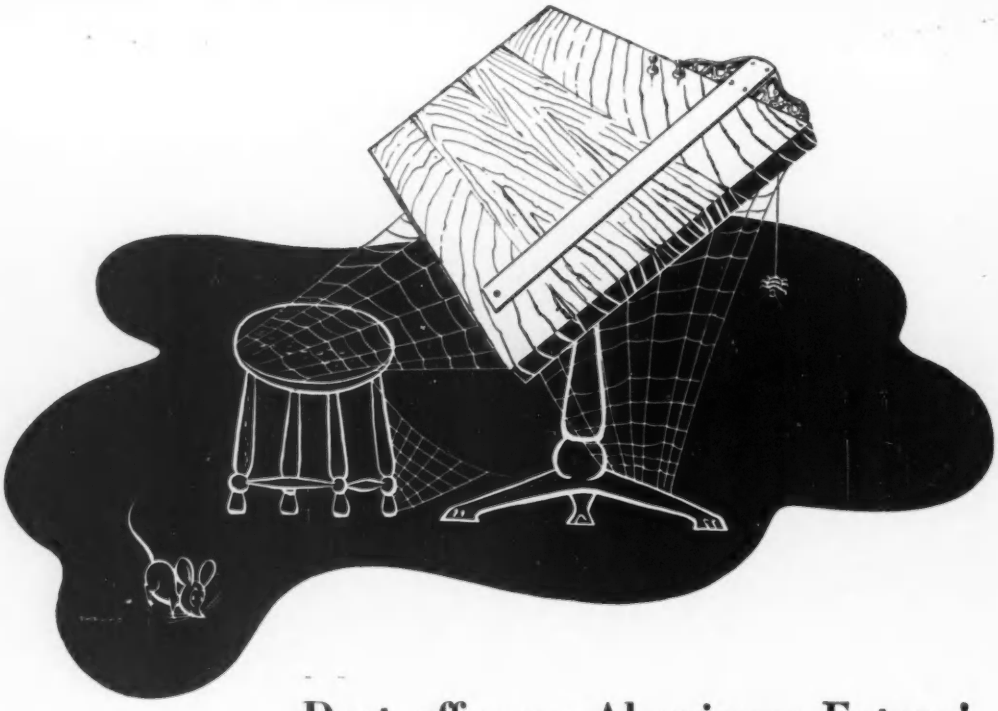

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

NONMETALLIC MATERIALS

A SPECIAL CELL perfected by Minnesota Mining & Mfg. Co. has put the production of a series of

fluorochemicals on a commercial basis. This electro-chemical device has solved the problem of handling fluorine and its compounds. Expected uses are in hydraulic fluids and lubricants.

PLASTIC PIPING is reported to outperform its metallic equivalent in applications where strong acids, alkalis and solvents are present. Called Tuffstuff by the Clopay Corp. of Cincinnati, this rigid polyvinyl chloride is extruded in standard pipe and tubing sizes. Conventional welding, cementing and bending procedures can be used during fabrication.

WHITE PAINT applied to the floor beneath the B-29 bomb bays being modified at Lockheed Aircraft's Marietta, Ga. plant, reflects four times as much overhead lighting as before and has made need for rigging extension lights on cords unnecessary. Speed-Rex paint has properties of fast drying, adhesion and resistance to abrasion.

IMPROVED FLUXES worked out by Solar Aircraft Co., San Diego, Calif., reduce fusion welding costs by controlling penetration, thus permitting higher welding temperatures without "burn-through". Recommended for use on heat and corrosion resistant alloys, fluxes are well suited to weldments requiring a "back-up".

"CONTACT RESINS", syrupy liquids usually of the alkyd or polyester class, polymerize in the presence of catalysts to infusible solids. This

property makes them suitable for complex laminated constructions that generally call for elaborate and expensive molds. With these resins, the mold can be made of plaster, wood, metal or glass fabric laminates. Engineers at Naval Air Development Center in Johnsville, Pa. are repairing rodomes with these low-pressure materials.

RUBBER-IMPREGNATED leather combines the low friction and high strength of leather with the good sealing, resilience and heat resistance of rubber. E. F. Houghton & Co. of Philadelphia produces this 1243 VIM material as "V" and cup packings that withstand a 200-F temperature, as well as resist oils and solvents.

LIGHTWEIGHT ACETATES metalized with a 0.001-in. thick colored film may take the place of metal foils that are becoming less easy to obtain. Flexible plastic, made by Coating Products of New York City, can be laminated to paper and board with the film sealed between layers.

METALLIC MATERIALS

THIS YEAR'S SAVINGS of critical metals in the radio and TV industries alone are estimated at

75,350 tons. Compared with 1950, typical savings of various materials are: Co-36%, Cu-24%, Ni-28%, Sn-25% and Zn-26%. Radio-TV Assn based figures on annual output 20 percent below '50.

PERMANENT MAGNETS made of materials other than strategic and costly nickel and cobalt are scheduled for production early next year. Philips Research Labs of Eindhoven, Holland have not released property data, but indications are that the new material stacks up well against some of the Alnico alloys.

CHROME CARBIDES having a nickel binder but no tungsten or cobalt were recently announced by the Carboloy Dept. of General Electric, Detroit. These Series 600 powder metals contain about 70 percent chromium by weight, have excellent resistance to abrasion and erosion, are half as dense as tungsten carbide and resist oxidation at temperatures to 1,830 Fahrenheit.

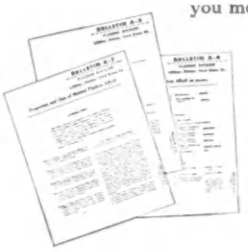
AS TITANIUM PRODUCTION goes up, U.S. imports of manganese can come down, a significant fact when it is noted that about nine out of ten tons of manganese are bought abroad. Metallur-

(Continued on page 7)

Twice as many per dollar

Changing to Plaskon Alkyd Molding Compound enabled Barber-Colman Company to cut the cost of molding these magneto rotors for J. I. Case tractors *in half* . . . "a 50% saving". And J. I. Case credits Plaskon Alkyd for satisfactory mechanical and electrical properties, with complete absence of objectionable electrical "tracking" across the rotors.

Applications of many types offer convincing proof that quick-curing Plaskon Alkyd can usually be molded *three to four times faster* than conventional thermosetting materials. This means that dies with fewer cavities may be used to achieve a given production rate. And because Plaskon Alkyd can be molded at lower pressures, maintenance of tools and presses is generally reduced. There are *so many ways to save* using Plaskon Alkyd for the molding of plastic parts! We will be glad to tell you more whenever it is convenient for you to see one of us.



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gists at the Southern Research Institute claim that titanium and zirconium as alloying elements in certain grades of steel perform nearly the same role as does manganese.

CONDUCTOR-GRADE aluminum and 0.001 to 0.5 percent boron from wire that has an electrical

conductivity at least 61 percent of figure in Annealed Copper Std. Patent 2,545,866, held by Alcoa, states alloy can be cold drawn from hot-rolled rod to a dia of 0.210 in. without an anneal.

CREEP TESTS made on high-purity lead and some of its alloys at the Baillieu Laboratories, University of Melbourne, indicate that varying surface conditions are not critical. Such is not the case with many of the common alloy materials recently creep checked in this country.

PROCESSES

PHOTOSENSITIVE PLATES made of anodized aluminum are the key to a Swiss reproduction process called Aluphoto. A substantially grainless image of high resolution is permanently registered in the anodized layer by conventional developing procedures. Advantage is the permanency of the image through its corrosion, wear and heat resistance. Horizons, Inc. of Cleveland holds the U.S. rights to the process.

A "LIQUID BLANKET" poured over molten zinc used for galvanizing wire stops the formation of zinc oxide "crusts" and makes possible 20 to 50 percent savings of the critical metal. Dewey and Almy Chemical Co. of Cambridge, Mass. reports the liquid does not have the porosity of "dry blankets" and also reduces spatter.

WET-BLASTING aluminum parts with a water-solution of sand removes the oxide film so that

parts can be chromium plated directly. Cro-Plate, Inc. of Hartford, Conn., who developed the blasting technique, states that parts must have simple contours to insure 100 percent cleaning.

CHROME-RICH LAYER diffused in ferrous alloys either replaces chrome plating or stainless steel. This Onera process, developed by the National d'Etudes et de Recherches Aeronautiques, Paris, centers around the decomposition of chromium fluoride at temperatures varying from 1,920 to 2,000 Fahrenheit.

WRINKLED flanges and beads are common on ferrous and nonferrous stampings formed between a rubber pressure pad and low-cost form blocks or dies. Often more time is required to pound out the wrinkles than to complete the initial press operation. North American Aviation has designed special clips that prevent wrinkling by restraining edges of sheet during forming.

SOME OF THE SECRETS to welding zirconium are being exposed through tests conducted at

Oregon State College, Corvallis, Ore. Carefully-controlled argon gas and shielded-tungsten arc welding plus annealing look the most promising. No oxygen or nitrogen penetration is evident in test pieces, but some loss of ductility is noticeable in the vicinity of the weld deposit.

CONTROLLED CASTING contributes largely to the performance of aluminum bearings. When discrete particles of tin are uniformly distributed throughout the aluminum matrix, the resulting alloy has the softness of babbitt and a high fatigue resistance at temperatures as high as 300 F. Tests are continuing at England's Tin Research and Fulmer Research Institutes.

COMPONENTS

UNLIKE CLUTCH PEDALS, automobile brake pedals are here to stay, but they will have a "new look." In the Bendix Treadle-Vac system to appear next year, the brake will resemble the ac-

celerator pedal and have a 3-in. instead of 6-in. travel. Special system components are a vacuum cylinder in the hydraulic line and a booster for supplying half the braking effort.

VANE-TYPE PUMP permits rapid regulation of volume and direction of oil flow to fit circuit and cycle conditions. Milwaukee Hydropower, Inc, does not use springs to position the vanes, but the pressure ring rotates with the vanes, thereby reducing friction and wear.

COLORED CAPS that snap onto grease fittings have a dual purpose, according to Van Dusen Aircraft Supplies, Teterboro, N. J. Pro-Kaps not only keep abrasive material clear of the grease inlet, but also act as indicators of fitting location and, with the aid of a color code, type of grease used at each fitting.

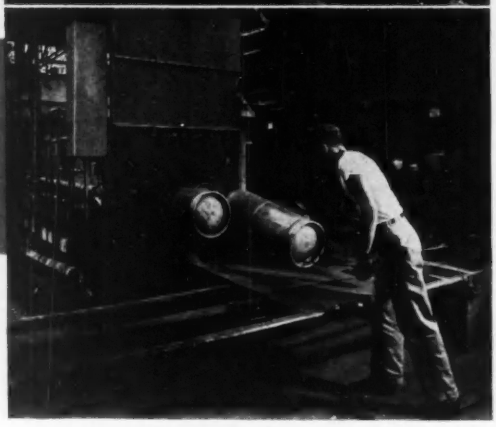
(Continued on page 9)

Metallurgical furnace investigations in the laboratory influence heat processing in manufacture.

Laboratory-proved techniques

assure the

factory-made quality



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To meet industry's ever-advancing needs for pressure vessels and deep-drawn shapes of lighter weight, higher strength, greater dependability and longer life, Scaife maintains constant research and engineering studies of materials, methods and products.

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The name SCAIFE on pressure vessels and deep-drawn shapes means highest quality and most advanced design.

Starting with a circular sheet of steel—
a cup is formed by a conventional drawing operation.
A continuation of this pressing operation turns the cup "inside out" without removing it from the dies,
completing—in a single stroke—the deep-drawn shape.
Deep-drawn shapes made by the Scaife reverse-draw process (described above) have uniform wall thickness throughout the entire length of the draw. Can be made in various lengths, diameters and symmetrical shapes.
Scaife cylinders are used for liquefied petroleum gases, freon, acetylene, sulfur dioxide and other materials. They are light in weight, strong and durable.
Scaife pressure vessels for air, gases and liquids are made in standard and special designs and for various types of service.

Makers of Pressure Vessels for Air, Gases and Liquids

Scaife Company

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SUBMINIATURE RESISTORS made by Instrument Resistors Co. of Union, N.J. are of sealed-in Bakelite construction and have a special coating that resists formation of fungus.

EIGHT HOOK-SHAPED TERMINALS extend from a 0.6-in. dia header hermetically sealed into a drawn aluminum 1-in. cube housing. Such are the design features of a miniature relay made by the Hermaseal Co. of Elkhart, Ind. Assembly can be panel mounted from top or bottom.

A "POWDERED GLASS BASE" is used on a 75-mc radiation-cooled tetrode to provide increased cooling capacity. Amperex Electronic Corp. of Brooklyn, N. Y. also reports that this type of tube construction obviates the need for an additional external base.

RECTIFIER TUBE, designed by RCA to meet military requirements under extreme temperature changes, is filled with xenon gas that gives it high efficiency at temperatures between approximately -100 F and + 200 F. It is to replace the mercury-vapor rectifier that fails to operate at these extremes.

TESTING

PROBLEMS OF SPRING DESIGN are solved with the Calculaide spring computer designed by American Hydromath Corp. of New York City. Computer correlates, in one setting, the variables in spring design. Typical values include outside diameter of spring, wire size in diameter and gage number, number of active coils, material and its torsional modulus G, maximum sheer stress, load and total deflection.

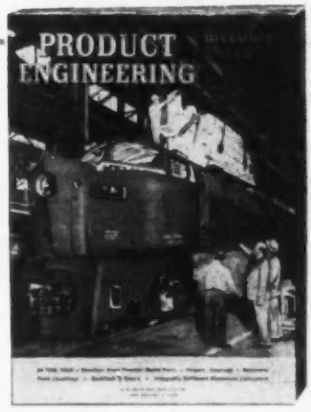
LACK OF "JET" ALLOYS has led NACA researchers to experiment with air and liquid cooling systems for preheating fuel and cooling jet engine components. Air system is far enough developed to mean significant savings in critical alloying materials.

MICRO-MOTION MOVIES, 16 mm pictures taken at rate of 1,000 frames per min, are the basis for certain changes in the design of machinery. Operator-motion studies made by Eastman Kodak reveal the need for relocating, combining, eliminating controls or revising the shape of operating parts on machines.

RAPID ANALYSIS of metals and alloys both qualitatively and quantitatively can be performed with an improved fluorescent type instrument designed by North American Philips Co. of Mount Vernon, N. Y. Analysis of solids, semi-solids and liquids is reported to be faster than by most of the ordinary chemical methods.

VIBRATORY MOVEMENTS can be accurately measured with a piezoelectric compressive accelerometer designed at the National Bureau of Standards in Washington. Pickup is composed of a barium titanate disk 1/16 in. thick and 3/8 in. in dia, stacked between a suitable base and a block of metal used for mass loading. Voltage generated in compressed disk is proportional to acceleration being measured.

A SPECIAL KIT that features miniature wires and cables of assorted sizes and types is designed for various experimental uses. Tensolite Insulated Wire Co., Tarrytown, N.Y., finds the main application is in work connected with electronic development and redesign projects.



THIS MONTH'S COVER

Engine being lowered into the cab of a new diesel electric road-freight locomotive at the Eddystone Plant of the Baldwin-Lima-Hamilton Corporation. More powerful than previous models, the 1,600 hp locomotive, designated RF-16, has a redesigned engine that accounts for part of the improved performance. The crankshaft is larger, the crankshaft is thicker, and the connecting rods are heavier. This basic engine is the same as that used in the 1,600 hp all service locomotive described on pages 134 to 137. However, the road freight unit has high speed trucks, different gearing and controls, and an entirely different body.

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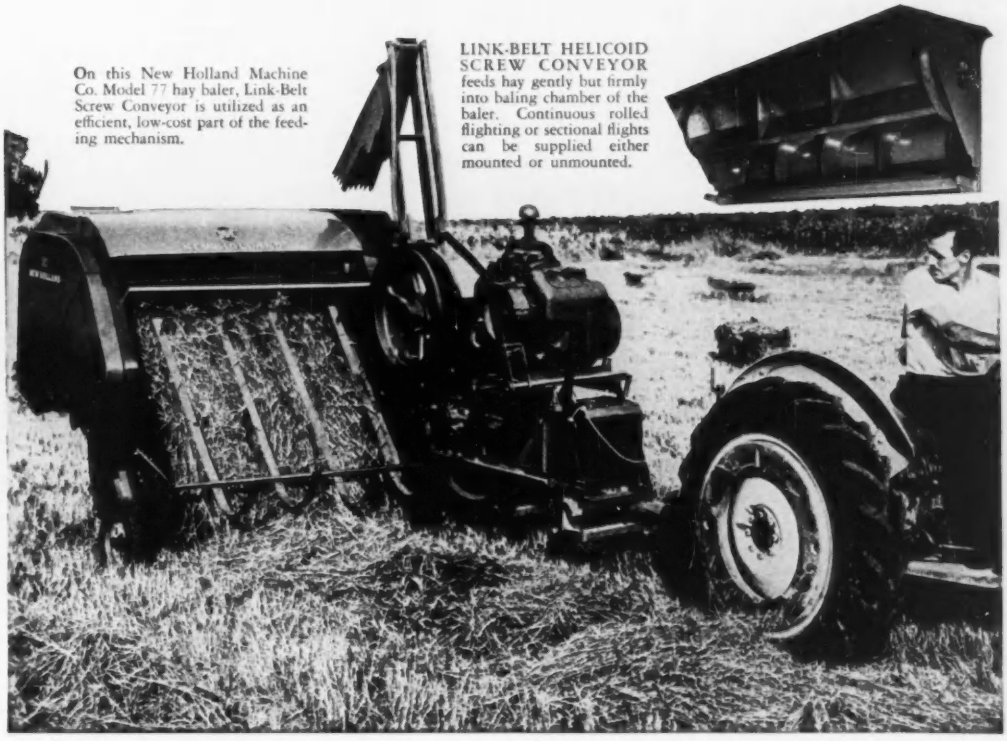
LINK-BELT HELICOID SCREW CONVEYOR feeds hay gently but firmly into baling chamber of the baler. Continuous rolled flighting or sectional flights can be supplied either mounted or unmounted.



MORE than capacity . . . more than length . . . are considered by Link-Belt engineers when they recommend a screw conveyor for your requirements. Abrasiveness, moisture content, size of feed, corrosiveness and many other factors are important.

Remember, Link-Belt is the nation's top producer of materials handling and power transmission equipment . . . another reason why Link-Belt Screw Conveyors are simple, compact, have few wearing parts, greater dependability. Then too . . . they're accurately made to insure easy assembly and smooth operation.

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LINK-BELT COMPANY: Chicago 8, Indianapolis 6, Philadelphia 40 Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 12,361

PROBLEM:

How to get a good contact surface on Magnesium to provide proper joint conductivity?

GENERAL PLATE

Provided the solution with "Copper on Magnesium . . . A composite Metal Combination"

Recently the General Plate was asked how to overcome the difficulty of attaching leads to magnesium and attain good joint conductivity.

General Plate Engineers provided the solution by bonding a thin layer of "copper on magnesium." This new type *clad* metal gave the contact surface required, as well as a surface on which soft soldering operations were readily performed.

No matter what your problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals, or base to base metals can overcome your problems . . . often reduce costs.

General Plate Products include . . . Precious metals clad to base metals, Base metals clad to base metals, Silver solders, Composite contacts, buttons and rivets, Truflex® Thermostat Metals, Alcuplate®, Platinum fabrication and refining, Age-hardenable, #720 Manganese Alloy. Write for information.

Have You a Composite Metal Problem? General Plate can solve it for you

GENERAL PLATE

Division of Metals & Controls Corporation

112 FOREST STREET, ATTLEBORO, MASS.

Here's how you can tell the chain with SHOT-PEENED rollers...

Thousands of tiny steel balls hammer the metal — "cold work" each roller . . . pay off in extra fatigue life . . . added ability to withstand shock and impact.

...the chain that has extra fatigue life

YES, you want to be sure you get shot-peened rollers on the next roller chain you buy. Shot-peening gives rollers the extra fatigue life needed to take repeated shock and impact loads.

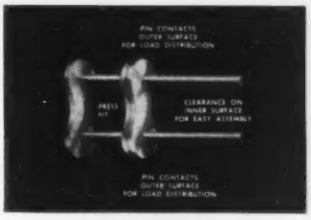
These chains are high in tensile strength, durable under severe loads, relatively light in weight and uniform in pitch. This accounts for their wide acceptance throughout industry for both drive and conveying purposes.

Thanks to constant research and precise manufacturing controls, every Link-Belt Precision Steel Roller Chain meets the highest standards for uniform strength. You get a positive, long-life drive — unaffected by heat, cold or moisture.

Link-Belt Roller Chain is available in single or multiple widths, in ⅜ to 3 in. single and double pitch. For all the facts, call your nearest Link-Belt office.

LINK-BELT

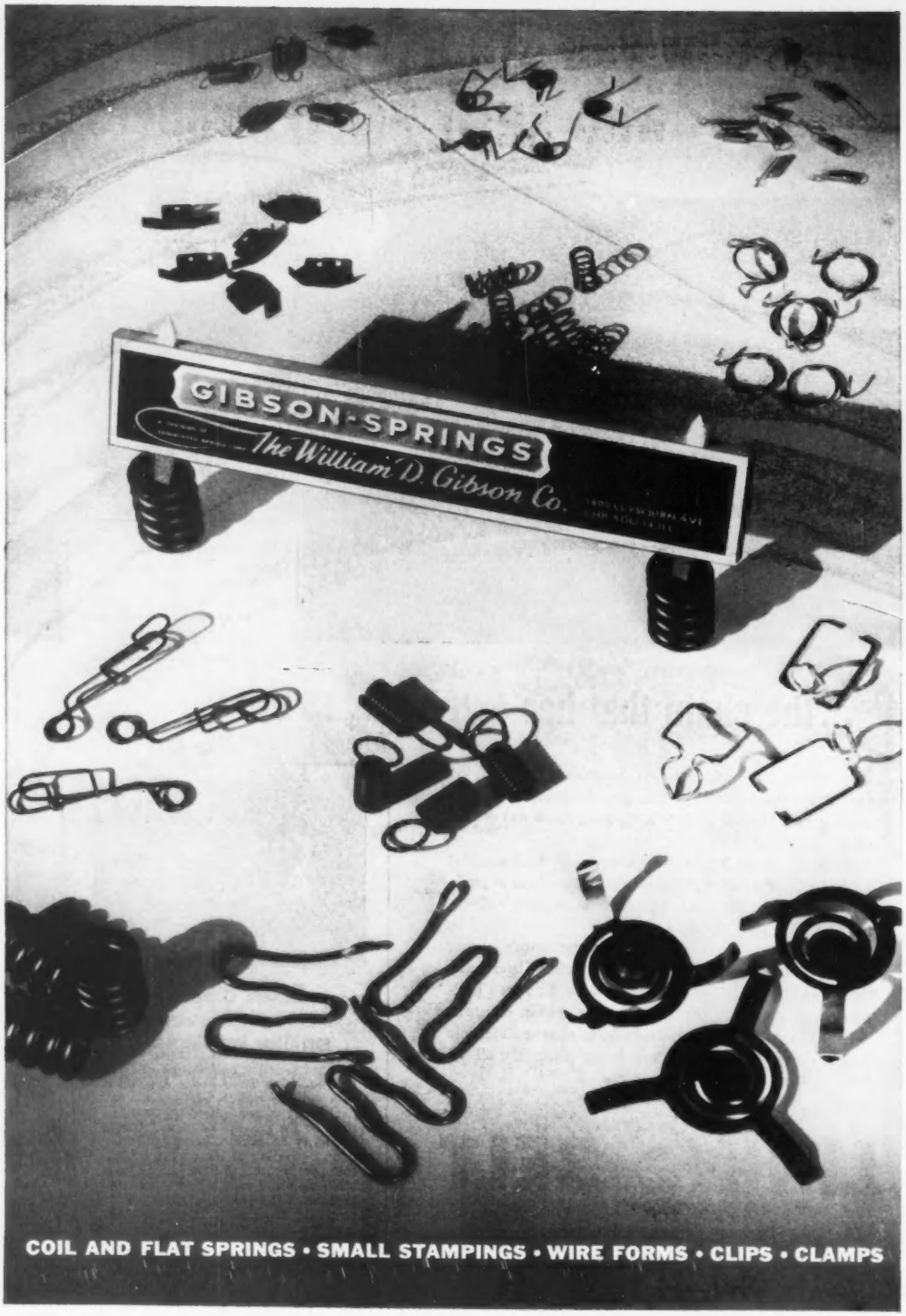
PRECISION STEEL ROLLER CHAIN



Easier coupling
and uncoupling without sacrificing load distribution

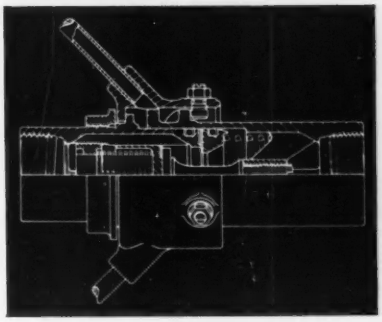
Patented E-Z Assembly feature of Link-Belt Precision Steel Roller Chain has won world-wide approval. Coupling and uncoupling of multiple width chains — right on the job — is far easier. There's absolutely no sacrifice of load distribution . . . no loss of the chain's remarkable performance. Press-fits between chain pins and middle bars have been modified. But full load carrying capacity across the entire width of the chain has been maintained.

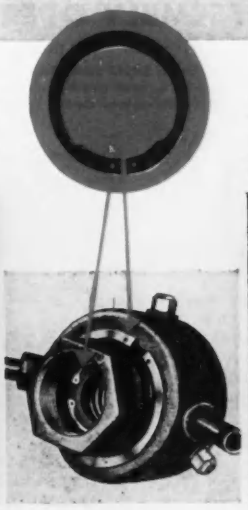
LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities. 12,332


GIBSON-SPRINGS
The William D. Gibson Co.
COIL AND FLAT SPRINGS • SMALL STAMPINGS • WIRE FORMS • CLIPS • CLAMPS

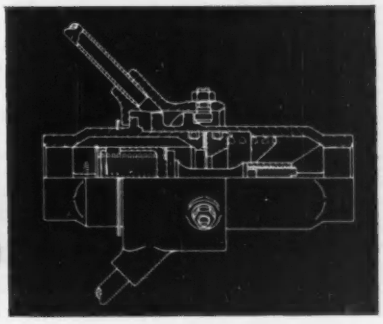
2 TRUARC RINGS
ELIMINATE BULKY THREADED RETAINERS
...SAVE 41 MINUTES...$4.02 PER UNIT

OLD WAY Oversize internal and external retainers required costly milling, turning and threading operations. Assembly and disassembly (for inspection and seal replacement) was slow, difficult and expensive. Wall thickness and weight were excessive





NEW WAY An internal (series 5000) and an external (series 5108) Truarc Ring are set into 2 grooves. Light, strong, economical Truarc Rings simplify assembly, disassembly, maintenance. Unit is smaller, more efficient. Greater accuracy because of positive stop positions!



Sperry Products, Inc., Danbury, Conn., saved 41 minutes in manufacturing and assembly time by using 2 Waldes Truarc Retaining Rings in place of old-fashioned threaded retainers in their self-sealing couplings! With Truarc Rings many tooling operations were eliminated... important savings per unit were made in raw material (1½ lbs. metal), overall size (3/16" diam.), and weight (1 lb.). Unit efficiency was greatly increased!

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered... quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

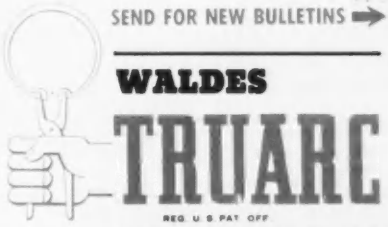
Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

USE OF 2 TRUARC RINGS ELIMINATED THESE COSTS

MACHINING:	
outer shoulder ring: 15 minutes	$1.12
inner retainer: 20 minutes	1.50
threading: 4 minutes	.30
ASSEMBLY	.13
Total labor savings	$3.05
MATERIAL:	
brass threaded retainers	.97
TOTAL SAVINGS WITH TRUARC RINGS	**$4.02**

For precision internal grooving and undercutting... Waldes Grooving Tool.

SEND FOR NEW BULLETINS ➡



WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,302,947; 2,302,948; 2,416,052; 2,420,021; 2,420,341; 2,439,795; 2,441,940; 2,450,169; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,300; 2,509,001 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. PN 123

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

Name_____

Title_____

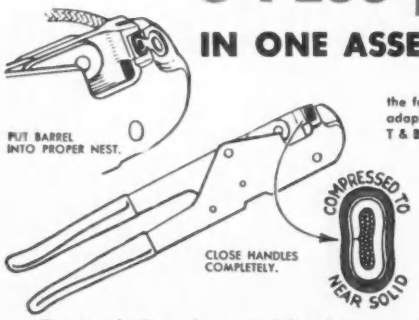
Company_____

Business Address_____

City_____ Zone_____ State_____ 5678

This combination gives you 3 PLUS-performance features

IN ONE ASSEMBLY OPERATION...



the famous SHURE STAKE Tool* has now been adapted to install also the new T & B Self-Insulated Sta-Kon Terminals†

For terminal-to-wire assemblies that are quickly and easily made . . . and stand up under the toughest service conditions . . . just close the jaws of these new SHURE STAKE Tools on T & B Self-Insulated Sta-Kon Terminals. You build these *three* service advantages into your products, in a *single* low-cost operation:

1. Electrically sound, mechanically strong joint. (Unique, time-tested SHURE STAKE toggle principle builds pressure of one hand up to 2000-pound staking force. *Ordinary* tools exert only 800-pound pressure.)

2. Firm gripping of wire insulation within insulated terminal body. (SHURE STAKE Tool closes both wire-gripping and insulation-gripping ends of terminal simultaneously.)

3. Terminal insulation that prevents shorts in close quarters—*without* an extra insulating operation. (Insulation is positively anchored in place when terminal is shipped—*remains* positively anchored during assembly and in service.)

RESULTS ARE SURE

With SHURE STAKE Tools, you get a top-quality assembly job *every time*. Once the jaws have started to close, they *can't* be reopened till *full* staking pressure has been applied.

And . . . it's a cinch to be sure you're using the right *size* tool. SHURE STAKE Tools, like Self-Insulated Sta-Kons, are *color-coded* for size. Just look for the terminal color on the tool handle!

Three tool designs meet all assembly requirements. WT-143 handles RA and RB terminals; WT-144 installs RC size; WT-141 is adjustable for all three sizes.

*Patents Pending †Patented

THERE'S A T&B ENGINEERED PRODUCT for every wiring job in the complete T & B line of fittings for all conductors and raceways.

Manufacturers of Electrical Fittings since 1899
Originators of self-insulated solderless terminals in 1935

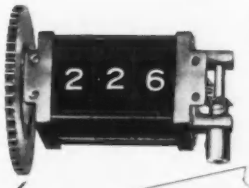
ENGINEERED RIGHT... DISTRIBUTED RIGHT... *These new SHURE STAKE Tools for Self-Insulated Sta-Kon Terminals are typical of the many T & B quality products recently re-designed to give you outstanding performance at lowest cost. Like all T & B products, they're furnished exclusively through local T & B distributors under the T & B plan.*

THE THOMAS & BETTS CO.

INCORPORATED

16 Butler Street, Elizabeth 1, New Jersey

Our Field Design Engineers are ready to help you on special fittings problems. Ask your nearest T & B distributor to arrange to have one get in touch with you.



Small Component... or Complete Unit... You* can count on getting whatever You* need—

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

This REEL CONTROL BOX, complete with its *built-in* counting mechanism, indicates the number of feet of antenna reeled in and out of certain types of military aircraft. Manufactured completely by Veeder-Root, including outside bakelite cover and box, this unit shows another imaginative application of the universal language of direct-reading *Count*rol.

Now if you, *in any of your defense work,** have a counting problem, then you can count on Veeder-Root to help you in every possible way.

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONN. • GREENVILLE, S.C.
Montreal 2, Canada • Dundee, Scotland
Offices and agents in principal cities

"Counts Everything on Earth"

Cork-and-Rubber Gasket Materials

made to meet government specifications

You can get samples from Armstrong of materials made to meet each class of the principal government specifications covering cork-and-rubber gasket materials. These materials are listed below.

Specification	Material	Specification	Material
MIL-G-6183			
Type I Soft	NC-709	Type II Soft	DC-167
Type I Medium	NC-710	Type II Medium	DC-100
Type I Firm	NC-711	Type II Firm	DC-113
MIL-T-6841	DK-153 or RK-304S	MIL-G-6747	DK-149

For additional data on the materials above, call your nearest Armstrong Industrial Division office or see Sweet's file for product designers.

New cork-and-rubber compounds. Armstrong's Research Laboratories are ready to develop new cork-and-rubber materials to meet new military requirements as they arise. Please discuss your needs with your nearest Armstrong representative . . . or write.

Cork compositions. There is an Armstrong Cork Composition made to meet each of the classes under Federal Specification HH-C-576, as well as each of the grades under specification MIL-C-16090.

Synthetic rubber compounds. Armstrong makes specialized synthetic rubber compounds for critical uses. Example: synthetic rubber valve washers for aircraft fuel and oil servicing nozzles made under MIL-N-4180.

Send for this gasket manual. It contains 24 pages of information designed to help you make the best use of Armstrong's Gasket Materials. Included are discussions of subjects such as designing gaskets to reduce cost . . . practical tolerances for resilient gaskets . . . designing gaskets for efficient sealing, and others.

You'll find, too, up-to-date data on cork-and-rubber, cork composition, and straight synthetic rubber gasketing materials. Included are current government specifications and tentative SAE-ASTM specifications.

See "Armstrong's Gasket Materials" in Sweet's file for product designers. For personal copy, write Armstrong Cork Company, Gaskets and Packings Department, 7112 Arch Street, Lancaster, Pennsylvania.

ARMSTRONG'S GASKET MATERIALS

Your nearest Armstrong Industrial Division office

ALBANY 10, N. Y., 64 Northern Boulevard, Telephone: 4-0131 • BOSTON 16, MASS., 131 Clarendon Street, Telephone: COpley 7-2490 • CHICAGO 54, ILL., 13-136 Merchandise Mart, Telephone: DElaware 7-0500 • CINCINNATI 2, OHIO, Temple Bar Building, 138 E. Court Street, Telephone: PArkway 3220 • CLEVELAND 15, OHIO, 209 Hanna Bldg. Annex, Prospect Ave. and E. 14th Street, Telephone: MAin 7900 • DETROIT 26, MICH., 10th Floor, Free Press Building, 321 Lafayette Avenue, West, Telephone: WOodward 3-5670 • GREENVILLE, S. C., 33 Norwood Place, Telephone: Greenville 3-5302 • LOS ANGELES 15, CALIF., 719 Bendix Building, 1206 Maple Avenue, Telephone: RICHmond 0286 • NEW YORK 16, N. Y., 295 Fifth Avenue, Telephone: MUrray Hill 4-6900 • PHILADELPHIA 2, PA., Robinson Building, Fifteenth and Chestnut Streets, Telephone: LOcust 4-4290 • ST. LOUIS 3, MO., 1205 Olive Street, Telephone: CHestnut 1757 • IN CANADA: Armstrong Cork Canada Limited, 6911 Decarie Boulevard, Montreal, Quebec, Telephone: ATlantic 4733.

what to look for in a gearmotor

look for

1. Remove end cap

2. Remove gear case cover

Horizontal Split Case Construction

Many hours of service and maintenance time are saved by this split case construction—an exclusive Westinghouse feature. The parting line of the case is on the center line of the bearings. This provides easy accessibility without the necessity of disturbing the motor, mounting or driven machine.

Two simple operations are all that are required to open the Westinghouse Gearmotor for inspection or servicing: (1) Remove end cap, (2) Remove gear case cover. A man and a wrench can complete the operation in record time.

The long service life of Westinghouse Gearmotors saves you time and money, too. High-quality components that assure you trouble-free performance include:

Taper-hardened helical gears for high efficiency and smooth, quiet operation.

Anti-friction bearings for permanent shaft alignment and minimum friction loss.

A simple splash-type oil system for positive and ample lubrication.

Bulletin DB-3600-H contains complete product information and application data on all Westinghouse Gearmotors. Write for your copy today. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

J-07301

YOU CAN BE SURE.. IF IT'S Westinghouse

GEARED DRIVES

GRAPHITAR

(CARBON-GRAPHITE)

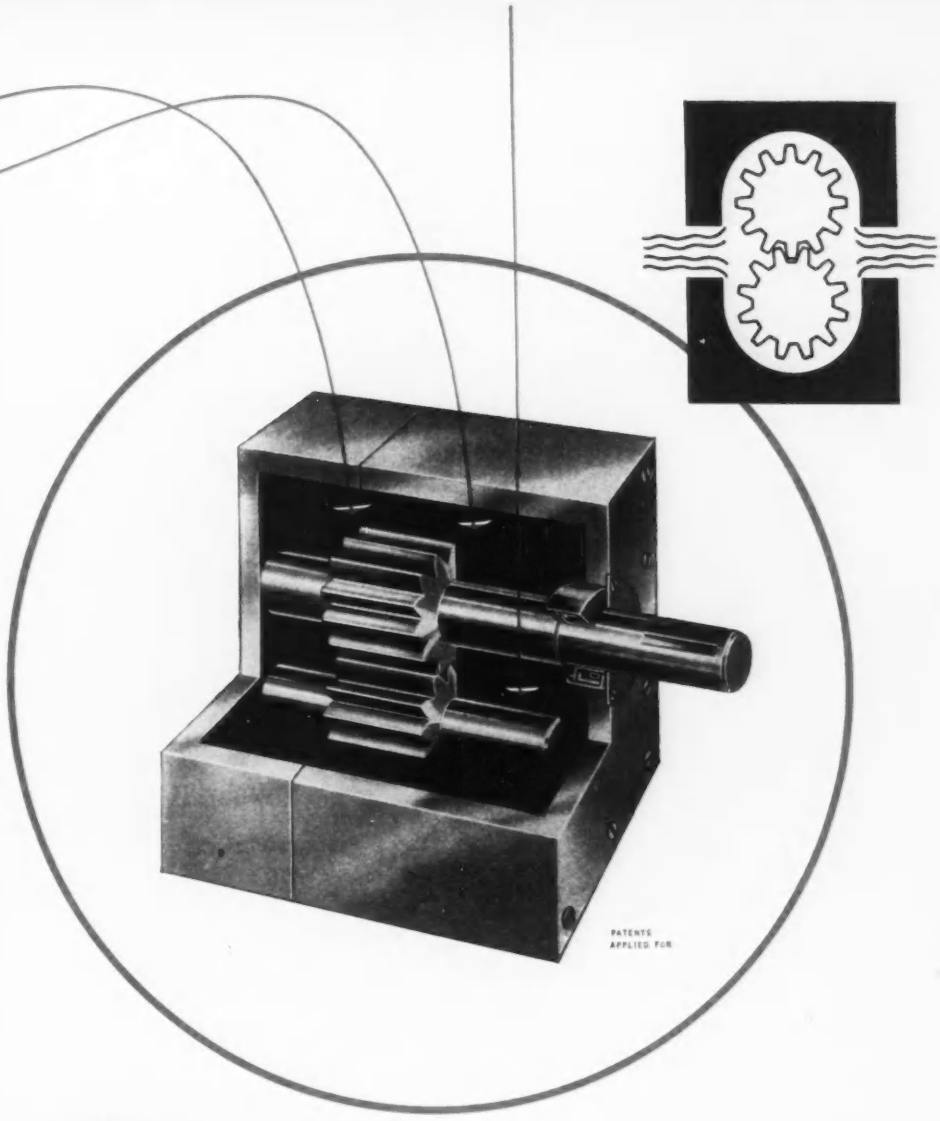
makes possible radical

Oberdorfer rotary gear pump

The housing for this versatile little rotary gear pump, made by the Chemical Pump Division of Oberdorfer Foundries, Inc., in Syracuse, N. Y., is machined from a solid block of pure Graphitar. Graphitar is probably the only material that could be used successfully in this particular application, because the pump must withstand the destructive action of a wide range of highly corrosive liquids and still operate efficiently without lubrication at speeds up to 1725 rpm. Graphitar is chemically inert—it will not corrode even when exposed to concentrated acids. Graphitar is also self-lubricating and highly resistant to wear.

GRAPHITAR is a highly successful carbon-graphite engineering material for a wide variety of seals, bearings, cylinder liners, pistons and countless other parts. It can be formed into relatively complicated shapes and ground to tolerances as close as .0005". Graphitar is extremely lightweight, yet mechanically strong and highly resistant to wear. It is practically unaffected by high temperatures and high speeds. Graphitar can improve the performance of your products and save critical metals such as steel and aluminum for defense production. For complete information, write today to . . .

THE UNITED STATES

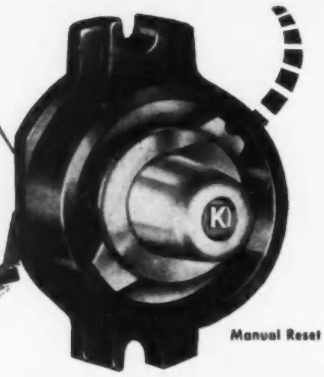


165

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Here's How You Can Reduce Costs...



Manual Reset Type

Specify and Use Motors With Built-in KLIXON PROTECTORS

- Eliminate Motor Burnouts
- Keep Production Going
- Reduce Motor Repairs and Replacements

Klixon Protectors in your motors are *one way* to keep today's rising operating and replacement costs down.

Built-in as an inherent part by the motor manufacturer, the Klixon Protector saves money and reduces idle machine time by preventing the motor from burning out. This means that you have less equipment shutdowns, less motor repairs and replacements . . . all adding up to substantial savings.

Here's how the Klixon Protector saves the motor — should the motor become dangerously overheated from overloads, high ambients, etc., the Klixon Protector snaps the power "off" preventing a possible burnout. When it cools to safety, the protector snaps the power "on" again automatically or by pushing the red button depending on the type of protector used. Temporary overloads do not cause nuisance tripouts.

As a user of electric motors, you can keep production moving, cut motor upkeep down to a minimum by ordering and using motors with built-in Klixon Protectors. *The additional cost is low* . . . pays dividends day in, day out.

Remember, always specify Klixon Protectors on your motor purchase **orders for positive motor protection.**

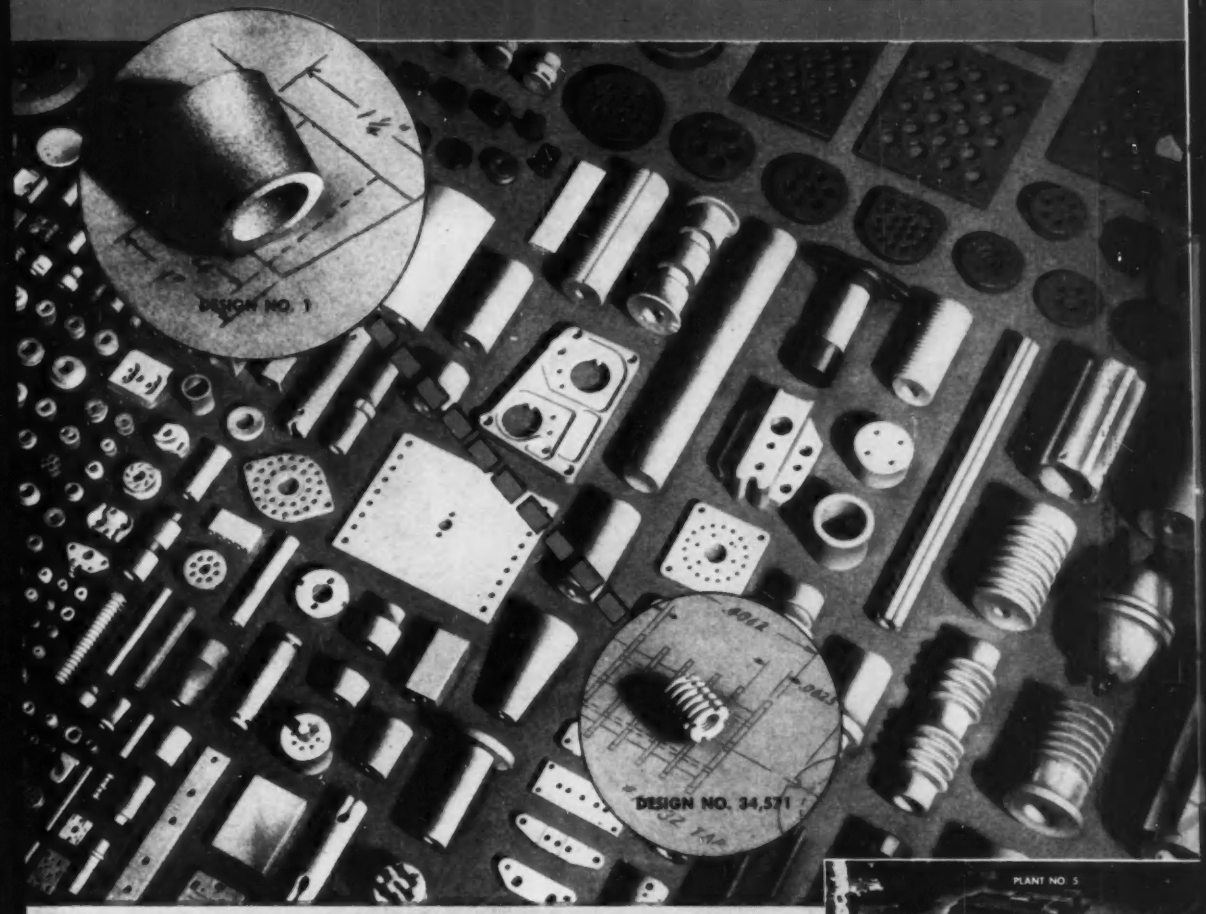
KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corp.

912 FOREST ST., ATTLEBORO, MASS.

34,571 designs + 50 years of specialized experience ARE AVAILABLE IN ALSIMAG®



On any problem involving technical ceramics, the cooperation of our engineers is available on request. Their half a century of specialized experience has enabled them to help solve many different design problems. Hand made experimental or test designs can be made quickly and at reasonable cost. When the design has been tested and perfected, quantity production is now more quickly available from our new plants which are in production.

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NEW ENGLAND, 1374 Massachusetts Ave., Cambridge, Mass., Kirkland 7-4690 • St. Louis, 1123 Washington Ave., Garfield 4959
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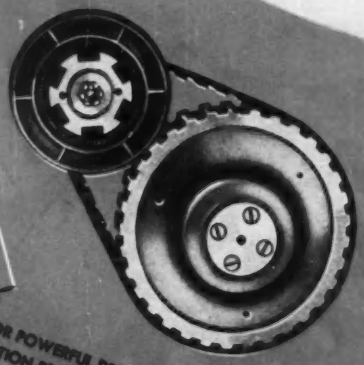
All Grip!
NO SLIP!

GILMER

FOR HEAVY LOADS AT HIGH SPEEDS —THE GILMER "TIMING BELT"!

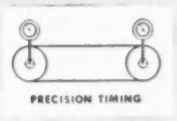


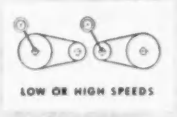
FOR POWERFUL DRIVE WITHOUT GEARS OR LUBRICATION PROBLEMS—THE GILMER "TIMING BELT"!

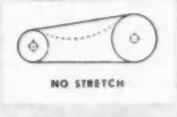
FOR POSITIVE SYNCHRONIZATION OF DRIVE COMPONENTS—THE GILMER "TIMING BELT"!

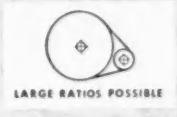
"TIMING BELT"* DRIVE

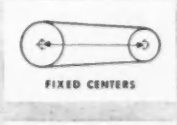
—newest idea in power transmission

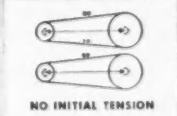












GILMER "TIMING BELT"
PATENTED 1950

The drive idea that's opened a world of new possibilities for designers! Already, on thousands of machines, in scores of industries, the Gilmer "Timing Belt" Drive has improved performance, cut costs, made possible power drive designs that are little short of revolutionary!

WHAT IT IS—The Gilmer "Timing Belt" is a *tooth-grip* belt that makes positive engagement with axially-grooved pulleys. It operates without slip or creep. And, because speeds of driver and driven pulleys synchronize perfectly, there's no speed variation—angular velocity is constant.

HOW IT'S MADE—High tensile-strength steel-cable pulling elements are embedded in a body of tough oil- and heat-resistant Neoprene. The flexible cables won't stretch—make it possible to operate belt on fixed centers without take-up adjustments; to use extreme pulley ratios without loss of pulling power.

WHERE TO USE IT—The Gilmer "Timing Belt" Drive is suitable for an infinite variety of applications: For power transmission; as a synchronizing drive; as a functional part—or any combination of these. Let our engineers help design your drive. We'll gladly send you an illustrated brochure which shows how leading design engineers are using it; gives valuable suggestions for drive designing. Write for it.

L. H. GILMER COMPANY
1203 Tacony, Philadelphia 35, Pa.
Division of United States Rubber Company

Gilmer BELTS

*Reg. Trade Mark

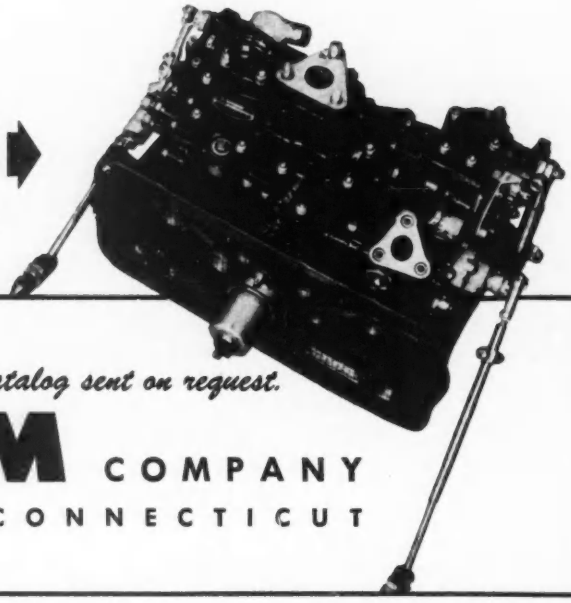
HEIM

Unibal

SPHERICAL BEARING ROD ENDS

Excellent results are obtained through the use of HEIM Rod Ends in flexible cable control systems such as this Teleflex mechanical remote control. The HEIM Rod End operates quietly, provides considerable weight saving, compensates for misalignment in all directions, and is available in standard sizes and diameters. Millions of HEIM Rod Ends have been used by the Army, Navy, and Air Force for use on aircraft, motorized equipment, motors, and applications where motion is to be transmitted at odd and varying angles.

Teleflex is a mechanical remote control system for transmitting motion or force from one point to another by movement of flexible cable within conduit. The system illustrated has a quadrant at the operating end and telescopic unit at the remote end attached to aircraft carb levers by HEIM Rod Ends.



Bearings and Rod Ends catalog sent on request.

THE **HEIM** COMPANY

FAIRFIELD, CONNECTICUT

Design Dept.:

Have we taken a look at plastics lately?

J.B.

Properties like these certainly can be used to our advantage

Send for this information from Monsanto today!

Imp Camera Service provides this ingenious idea for picture taking. Camera molded of Lustrex styrene by Northwest Plastics, Inc. for Beaurline Industries, Inc. both of St. Paul, Minn.

Got the latest picture on Lustrex styrene plastic?

New developments in Lustrex styrene plastic made this new idea possible. First requirement was the idea for designing this ingenious camera service. Next was the material to bring it to life.

The "idea" here is to supply film already loaded in a camera so you can take pictures and have the use of the camera. Snap your pictures, put the camera in the mail (it comes in a handy self-mailer package), and you receive back twelve prints. The manufacturer reloads and starts the camera on another round of service.

Lustrex styrene fits into this picture from every angle—provides high strength with light weight, good dimensional stability, low-cost mass production economies through fast injection molding.

For your own product . . . or new idea . . . investigate Monsanto's big *family* of plastics. And, for expert materials engineering assistance, send your materials or design problem to THE MONSANTO TECHNICAL COUNCIL—a board of ten plastics technicians whose experience and knowledge blankets the plastics industry. Probably they can help you make an old product better . . . bring a new product to life.

Send for your free copy of Monsanto's booklet, "Idea Generators."

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- ☐ Please send information about the Monsanto Technical Council and how they can help us.

Name & Title

Company

Address

City, Zone, State

TEN TIMES THE LIFE AND STILL GOING STRONG!

Ni-Hard† Pipe Proves Superiority in Resisting Abrasive Action

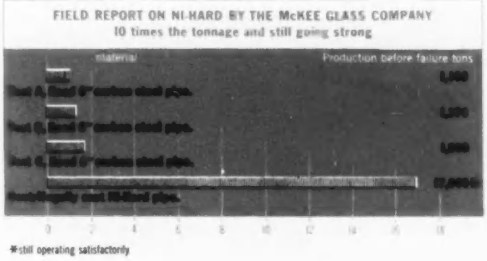
If your problem is abrasion, you'll be interested in this case history of Metal Mold centrifugally cast Ni-Hard pipe in action.

The McKee Glass Company, one of the nation's leading producers of molded glass for household and industry, uses a pneumatic conveyor system to handle its glass furnace charges. In this system tons of silica, sand, feldspar, borax, etc., are hurled at tornado-like speeds . . . about 100 miles per hour . . . through vacuum lines from boxcars to storage bins. Broken glass scrap (cullet) is added at the mixers to form a highly abrasive mixture.

Two years ago when the system was installed steel piping and later, lined steel piping was used. The severe abrasive action coupled with serious discoloration of the glass led to the search for a better conveying material. As a result, Metal Mold centrifugally cast plain end Ni-Hard pipe with a Brinell hardness of 600-650 was installed in the line's most abrasive sections.

The result, as reported by McKee, was more than satisfactory. Contamination was reduced 80%. Ni-Hard resisted abrasion much more effectively, as shown by the chart below . . . thus far, in fact, has carried *ten times the tonnage and the line is still going strong!*

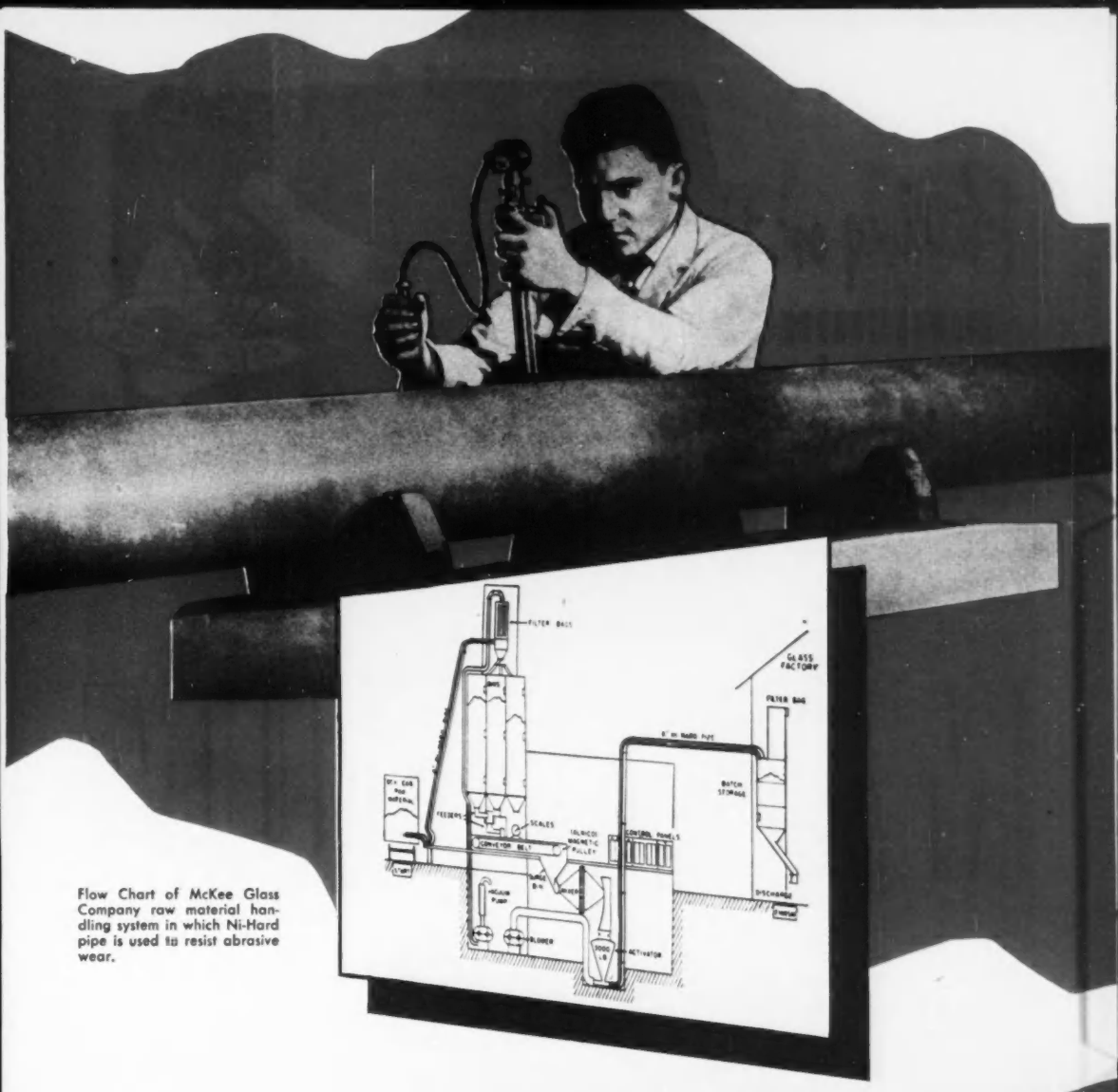
Today, the McKee Glass Company uses Ni-Hard exclusively in its conveying system. Their experience may suggest the answer to *your* abrasion problem.


FIELD REPORT ON NI-HARD BY THE McKEE GLASS COMPANY
10 times the tonnage and still going strong
Material
Production before failure tons

*still operating satisfactorily

†Nickel-chromium white cast iron.
Ni-Hard is a registered trade name of The International Nickel Co., Inc.

U. S. PIPE AND
SPECIAL PRODUCTS DIVISION
AMERICA'S LARGEST PRODUCER OF CENTRIFUGUALLY



Flow Chart of McKee Glass Company raw material handling system in which Ni-Hard pipe is used to resist abrasive wear.

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"Dual Metal"—Gray or alloy iron bi-cast over gray iron bi-cast clothed iron and tool steel, iron or steel bi-cast stainless steel over other centrifugally bonded two-metal centrifugally cast combinations.

SIZE RANGE

Outside diameters—2½" through 30". **Wall Thickness**—¼" to 4". **Lengths**—Up to 14'.

Putting on the FINISHING touch is a cinch...

MAGNESIUM

Yes, putting a protective finish on magnesium can be done easily, economically and with satisfactory results. The procedures used do not differ greatly from those employed with other metals. After thorough cleaning, a chemical finish is applied and this is followed by the desired paint coating. The important considerations are the proper choice of chemical treatment and paint materials.

Dow has exposed thousands of paint test panels to determine the best paint materials and the most efficient complete paint systems. As a result, paint systems are available which meet normal requirements and combine adequate protection with attractive decorative characteristics. Detailed recommendations are available for conditions under which magnesium is used in service ranging from baked enamel systems for office machines to weather-resisting, air-dried primers and finishes for truck bodies and trailers.

For complete information on finishing methods call your nearest Dow sales office or write direct.

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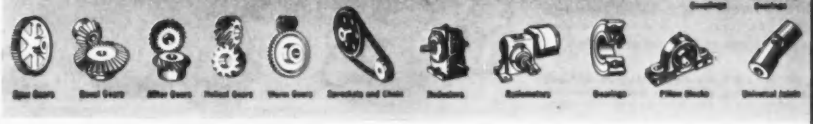

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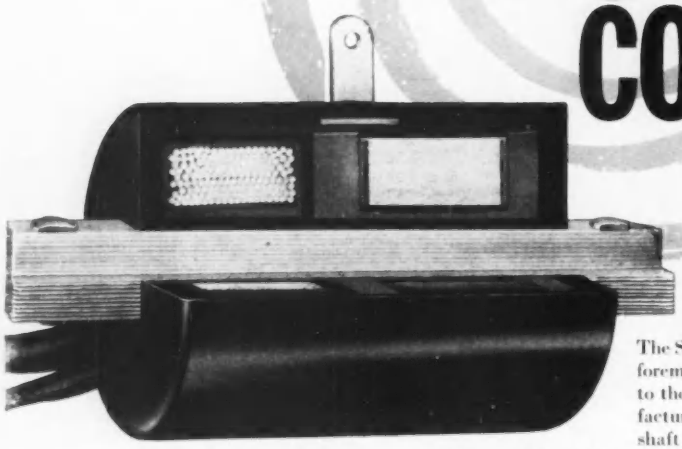

The Scintilla Magneto Division of Bendix, foremost supplier of ignition equipment to the aviation industry, offers the manufacturer of small industrial engines crankshaft and flywheel magnetos with a new and exclusive high output coil that adds immeasurably to engine performance.

With coil windings side by side instead of the conventional high tension superimposed upon low tension, output is materially increased providing easier starting and better performance.

Regulated voltage with increased breaker life and reduced electrical stresses assure trouble-free operation and longer life.

For better engine performance it will pay you to insist on Bendix magnetos. They are available for every type of small engine and every pricing requirement. Complete information on request.

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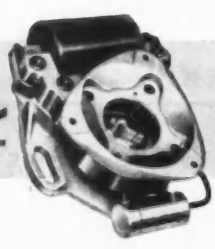

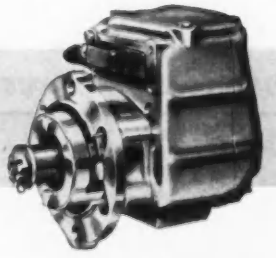

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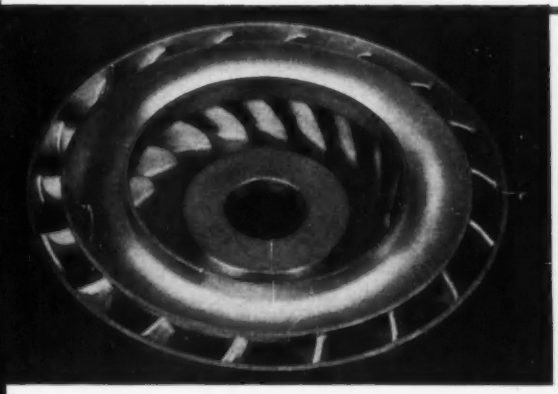
Aluminum

Government regulations limit the use of aluminum for other than essential products. The facts presented here are to help you speed this essential work and get the most out of available metal.

Here Alcoa shows its latest design techniques and newest fabricated forms to help designers with Rearmament Problems.



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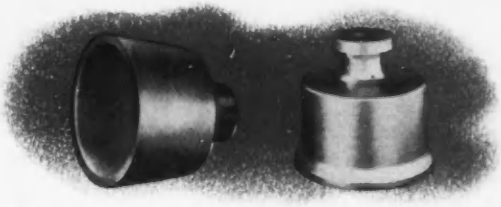

Aluminum Forgings

Their low density and high tensile strength merit serious consideration for high-speed rotating parts.

High tensile strength alone is not sufficient to guarantee satisfactory performance of high-speed rotating parts. In any rotating part, the magnitude of stresses is directly proportional to the density of the material used. Thus the stresses in a heavy metal part are about three times greater than the stresses in an aluminum part.

Density also influences the power required to accelerate or decelerate the part. For example, if it took 8.7 horsepower to accelerate a 12" disc of aluminum from 0 to 10,000 rpm in 10 seconds, it would take 24.8 horsepower to accelerate a similar steel disc under the same conditions. If the speed were to be increased from 0 to 20 000 rpm in the same time interval, the aluminum disc would require 35 horsepower — the steel disc, 100 horsepower.

Rotational stresses increase in proportion to the square of the speed. For example, if centrifugal stresses in an aluminum disc were 10,000 psi, the stresses in an identical steel disc would be 30,000 psi. If the speed were doubled, the stress in the aluminum part would be 40,000 psi and 120,000 psi in the steel disc.

Because of Alcoa's wide experience in designing, forging and testing high-speed rotating parts, our specialists are exceptionally well-qualified to assist you in design and alloy selection. Basic design considerations are covered in Alcoa's 171-page book, "Designing for Alcoa Forgings". Write for your free copy.

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Finishing Aluminum

Vitreous Enamels provide abrasion and heat-resistant coatings for aluminum. They adhere well, are easy to apply.

The sequence of operations for applying vitreous enamels on aluminum are: cleaning, spraying, oven drying, fusing the enamel frit at high temperature.

Parts are cleaned by wiping with cloths saturated with solvents or by vapor degreasing. Inhibited alkaline cleaners should be used. The enamel frits are mixed with water or turpentine, sprayed on and oven-dried. Quick drying by oven is important because the free alkali in the enamel mixture will cause surface corrosion if parts are left to air-dry.

The enamel is fused at temperatures from 940 to 1000° F. This heat will partially anneal temper rolled sheet. The heat treatable alloys will be partially heat-treated, but not to a full degree, because quenching is not possible.

Vitreous enamels on aluminum have the advantages of excellent resistance to impact and thermal shock. Certain coatings have exceptional resistance to mild acids.

For complete information on finishing Alcoa Aluminum write to the address below.

Aluminum Die Castings

The difference between average and exceptional die castings is often the kind of design help the supplier offers. Consider Alcoa's qualifications.

Alcoa offers the kind of technical literature and personal design consultation that you would expect from the leader in the aluminum industry and a die-casting supplier of 34 years' experience.

The help of an Alcoa sales-engineer is instantly available through your local Alcoa sales office. He is thoroughly familiar with the methods of applying aluminum die castings to your particular design problems. He will accurately interpret your production problems to the casting experts

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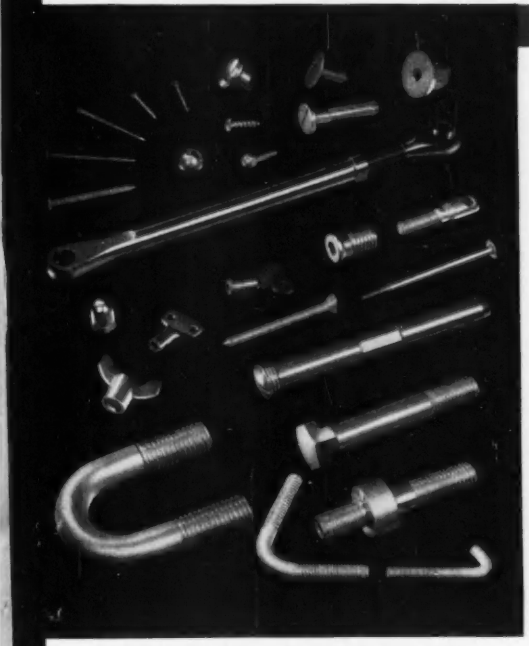
at Alcoa's two modern die-casting plants. Often the simple suggestions that come from the close attention that Alcoa experts give your drawings can result in substantial savings and surprising increases in the performance of the finished product.

For the designer's technical library, Alcoa offers two books: "Designing for Alcoa Die Castings" — a 188-page book which covers all phases of design, machining and finishing. And "Machining Alcoa Aluminum" — a 67-page book which describes tooling, setup and machine speeds for all machining operations. Both books may be obtained through your local Alcoa sales office or by writing direct to the address given below.



Besides standard and special fasteners, Alcoa produces bushings, inserts for plastic and cast products, nozzles, valves, aircraft parts, electrical fittings, couplings, pipe and tube fittings.

Aluminum Fasteners

Alcoa supplements its complete line of standard fasteners with a broad range of special fasteners made to customer specification.

The capacity and versatility of Alcoa's headers, threaders, slotters, screw machines and related secondary equipment permit Alcoa to provide industry with thousands of standard and special fasteners made from aluminum alloys.

Alcoa's 63 years of aluminum experience can be counted on to provide the best obtainable products of this type. Engineering and design assistance are readily obtainable for analysis of your parts to determine where costs can be lowered and quality improved. Special tools and gauges are built in Alcoa's own toolrooms to facilitate production and inspection. And there is capacity in Alcoa's plants for reasonable delivery schedules to manufacturers with authorized production schedules and metal allotments.

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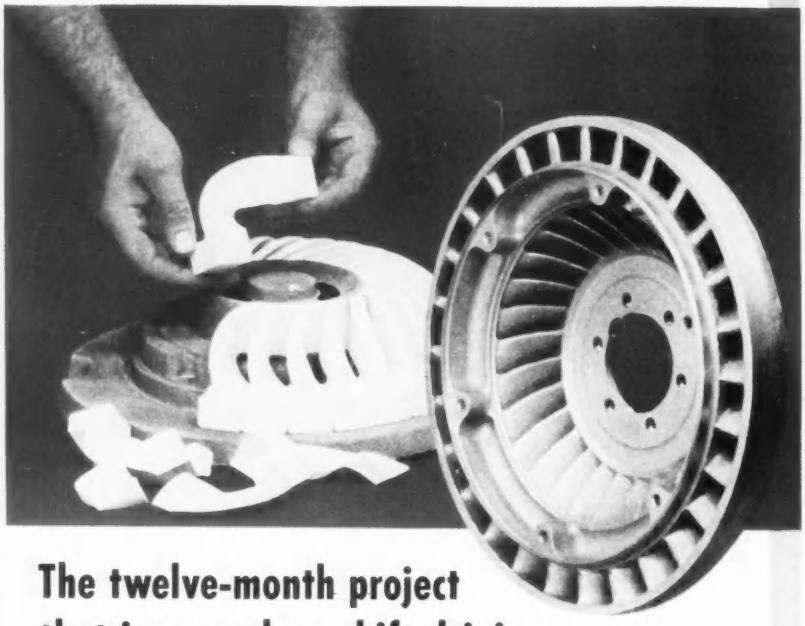

The twelve-month project that improved no-shift driving

Have you a similar problem? Submerge two fans in oil, facing each other. Couple one to an automotive engine. As it turns, it drives the oil against the other fan, transmitting power. This fluid coupling principle is the heart of new type automatic transmissions.

One automobile manufacturer set out to improve it to the Nth degree.

Torque converters had been made by machining cast or forged blanks, or by assembling stamped parts. But these engineers wanted better performance. This meant their converters must be stronger, lighter, more intricate. They asked, "Can we do it in aluminum?"

Our Research specialists saw the chance to show the economy of a little-known process called plaster casting. A process in which plaster, instead of sand, is used for cores to provide more intricate and smoother castings—castings that require no machining of the blades. It promised results that might even exceed the auto maker's requirements.

Final design refinements were made. Then we cast the first samples. They came from the molds smooth and clean—perfect in detail.

While the auto manufacturer machined them to finished dimensions, we set up to test them for strength at high speeds. Coating the parts with brittle lacquer, we spun them in our whirlpit up to 10,000 rpm—over twice their normal operating speed. Cracks in the brittle lacquer told us where strains concentrated. Designs were modified. New samples cast. Tests repeated. The final castings are smooth, faithful in detail, exceed every strength requirement.

This manufacturer's requirements of intricate shapes, strength and lightness may differ from yours. But they were met, as yours can be, by a long-range program of research, test and development. Such a long-range program, started now, may place your company in a commanding competitive position in the years ahead.

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there are no limitations on *Imagineering*

for such 1

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Marine Industry
Mining Equipment
Paper Machinery
Petroleum
Pressure Vessels
Printing Machinery
Railroad Equipment
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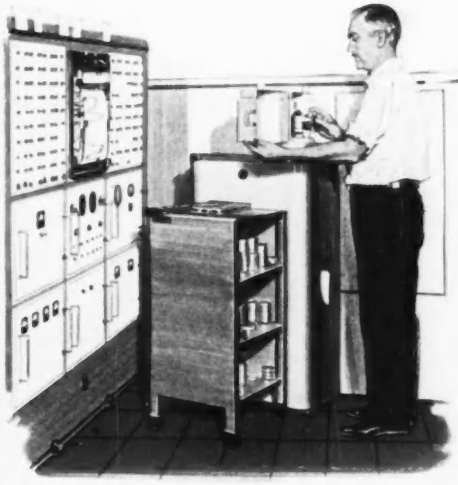
Textile Machinery

Among these specialists at the Development Division are men already familiar with the problems of your industry. They are your liaison with the Alcoa research, test and fabricating facilities that can be put to work on your problem. Through them the sum total of Alcoa's knowledge will be brought to bear. Knowledge of practical problems of fabrication and costs, gained in thousands of other projects, will flow toward yours.

DEVELOPMENT DIVISION

long-range projects we have these to offer:

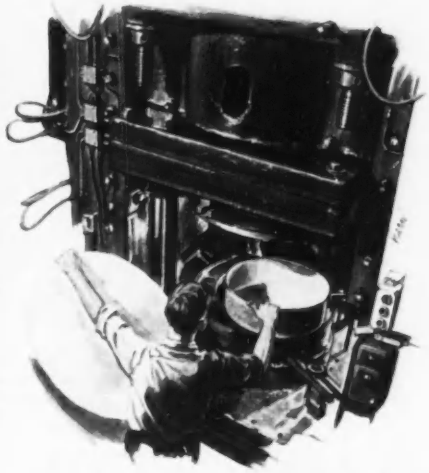


2 FACILITIES FOR BROAD *Research*

A complete chemical analysis of any aluminum alloy in 40 seconds! It's done with Alcoa's Electronic Quantometer. Similar machines are being installed in major Alcoa plants to make sure that the alloy which Research recommends for your job is delivered in the finished part.

3 ADVANCED *Test* EQUIPMENT

Checking the theories of basic research takes equipment like Alcoa's whirlpit, capable of speeds up to 70,000 rpm. Unforeseen residual stresses and deformation occur when a part is spun at high speeds. Stressing such a part to failure gives a firm foundation of fact on which to base design changes and safety factors.



4 *Process Development Shops* FOR PILOT AND MODEL WORK

After thorough research and testing, the actual fabrication of your project in aluminum may pose further problems. Here Alcoa makes available all the techniques of welding, forming, machining, casting, heat treating and finishing to create a practical pilot model, then suggests low cost, efficient methods for its fabrication.

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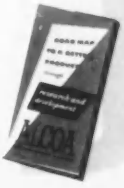
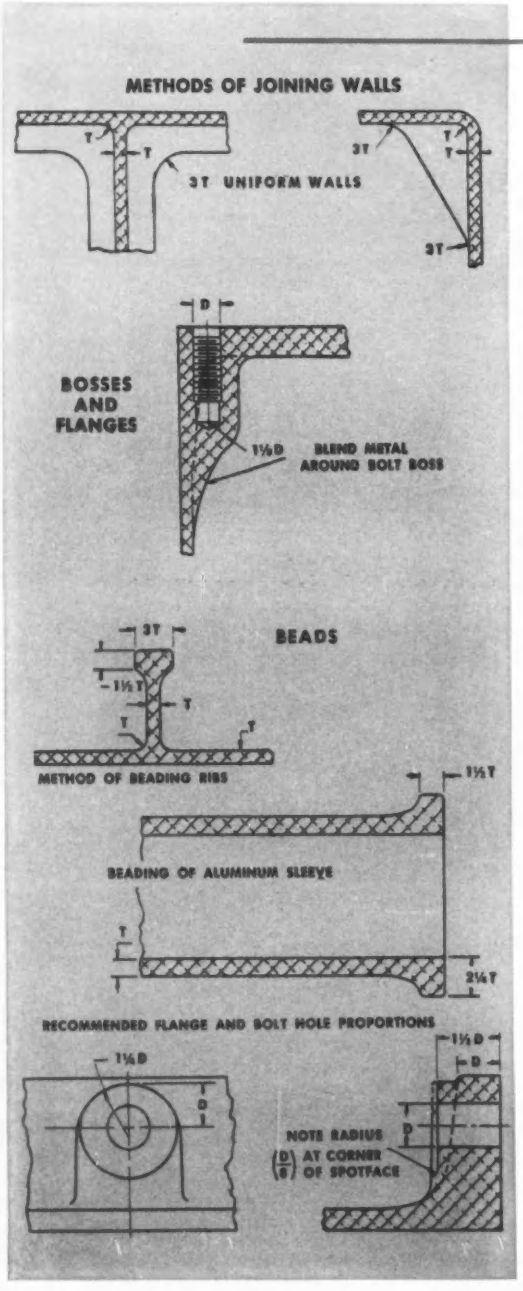


For more details . . . on the personnel, research and testing, and shop facilities available at Alcoa, write for your copy of the folder, "Road Map to a Better Product." It is your first step toward putting 63 years of aluminum knowledge to work on a long-term project that may effect a major change in your company's competitive position. Address ALUMINUM COMPANY OF AMERICA, 2185L Gulf Bldg., Pittsburgh 19, Pennsylvania.

Aluminum Castings



Consider . . .

- **Alcoa as a source of supply . . .**
- **Modern foundries strategically located from coast to coast . . .**
- **63 years of light-metal experience.**

Following a few general rules to make sure of stronger, more uniform castings at minimum production cost.

SECTIONS — Try to design sections that are tapered in a way that facilitates flow of metal. If tapered sections are not practical, section thickness should be kept as uniform as possible. When it is necessary to join light and heavy sections, the thinner section should be gradually increased in thickness toward the junction.
Extremely thin sections should be avoided since these require high pouring temperatures resulting in poor metallurgical structure and loss of mechanical strength. Minimum section thickness in sand castings is usually $\frac{1}{16}$ inch; in permanent mold castings, $\frac{1}{8}$ inch.

FILLETS — Use generous fillets at all intersections as well as between ribs and bosses and their supporting sections. Fillets adjoining two sections of equal thickness should have a radius at least equal to the thickness. Filleting aids the flow of metal . . . minimizes shrinkage and cracking.

LOCATING POINTS — Plan locating points so they can be used by the foundry and pattern shop for checking dimensions, and by the machine shop in machining. Space these as far apart as the size of the casting permits and, preferably, all on the same side of the parting line so they will not be influenced by shifting of core, cope or drag.

INSERTS — If inserts of other metals are used in aluminum castings, be sure to provide sufficient metal around these inserts to protect the casting against stresses set up by different rates of expansion and shrinkage. Be sure, too, that strong mechanical bonds exist — slots, legs, dogs, and similar projections accomplish this.

PARTING LINES — Keep parting lines as straight as possible. The cost of producing castings with uneven parting lines is usually greater than the cost of redesign to straighten parting lines.

ALCOA ALUMINUM

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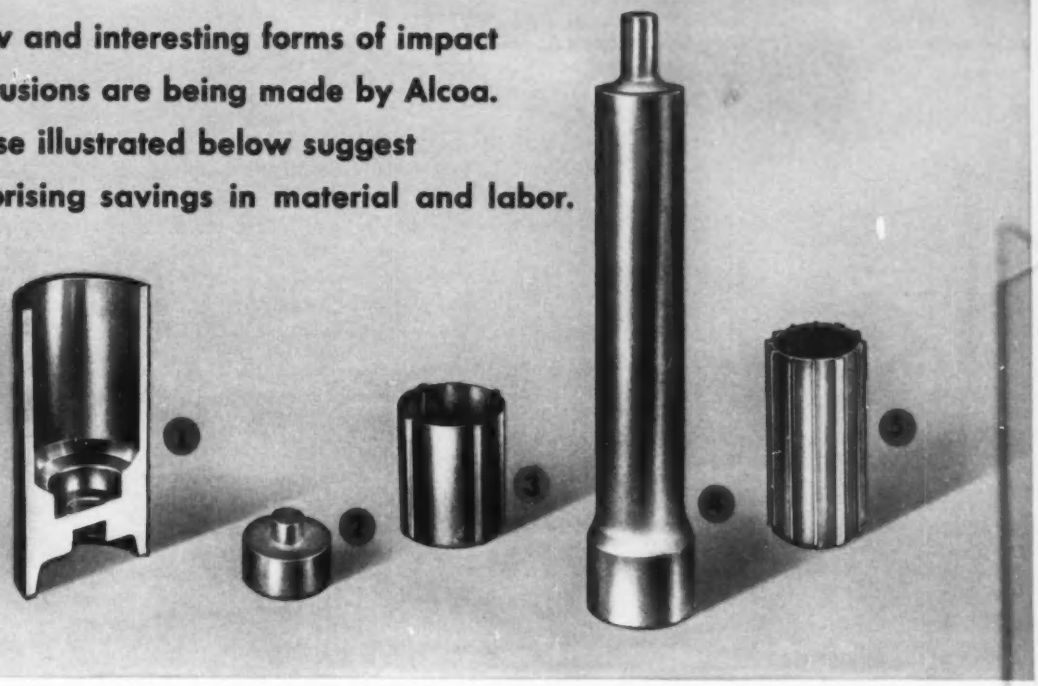
Aluminum Impact Extrusions

New and interesting forms of impact extrusions are being made by Alcoa. Those illustrated below suggest surprising savings in material and labor.



● **Shell Body** — This part shows the trend to higher strength alloys for impact extrusions. Extruding this heavy, massive part in 14S-T6 alloy is less expensive than machining the part from bar stock. Performance is improved due to the better grain structure inherent in impact extruded parts. And, produced as an impact extrusion, this part uses considerably less metal.

● **Motor End Cap** — While this part requires secondary machining to be completed, its manufacture by impact extrusion saved greatly over the previous method of machining the entire part from bar stock.

● **Electric Motor Housing** — Impact extruding this part replaced several drawing and forming operations. While the impact extruded part has no particular performance advantage over parts made by other processes, manufacturing costs are far lower when the part is extruded. The matched ribs around the outer surface of this part illustrate the versatility of impact extrusions.

● **Hydraulic Cylinder** — This is another part extruded from high-strength alloy, 61S-T6. Previously machined from bar stock, it is far less expensive as an impact extrusion. The stepped wall at the open end of such a massive, heavy part is of particular interest — a bargain in metal saving.

● **Electric Motor Housing** — These parts were previously assembled from hollow extrusions. Switching to impact extrusions with an integral bottom proved much more economical and improved performance, too.

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Aluminum Extrusions

permit placement of metal where maximum strength is needed... save greatly in material and fabrication costs.

Almost any shape can be produced by Alcoa — hollow, semi-hollow, solid. While cross sections must remain constant throughout the length of the shape, extrusions permit thick sections where stresses are concentrated — thin sections in areas of minor loading. In both metal cost and shop time, extrusions often can save substantially over roll forming or building up an equivalent section.

To help you visualize the almost limitless possibilities of aluminum extrusions, and to suggest ways you can adapt your designs to them, Alcoa has prepared a special booklet that's yours for the asking. Write for "Alcoa Aluminum Extruded Shapes."

Booklet offers basic design help...

- a discussion of design and production advantages of aluminum extrusions.
- examples of aluminum extrusions that have increased strength and stiffness because of efficient metal distribution.
- examples of designs that have been simplified by the use of a single extruded shape to replace expensive built-up assemblies, castings or machined sections.
- illustrations of the way several extruded shapes can be combined to simplify assembly and reduce costs.
- suggestions on modifying designs to utilize standard shapes and shapes for which dies are available.

ALCOA

ALUMINUM COMPANY OF AMERICA • 1807M GULF BLDG., PITTSBURGH, PA.

Filament nylon cloth is now "set" to prevent shrinkage in the finished garment by using Calrod heaters mounted several inches above . . .

NEW TEXTILE MACHINE DEVELOPED

Built-in Calrod* heaters enable continuous radiant-heat equipment to replace batch-type process

Radiant-heat setting of nylon on the production line now eliminates four very costly steps from the eight handling operations . . . and now uses semi-skilled labor. "The new Nylon Electrosetter gives our customers faster production at much lower cost per yard *solely* because of built-in electric heat," says John McCreary of McCreary Machine Works, Inc., Cohoes, N. Y. "And we chose Calrod heaters because they are easy to install, require almost no maintenance and are extremely reliable at temperatures even above 1300 F. When nylon valued at $3000 per hour runs on the tenter frame . . . the heat *must* be reliable."

If you build equipment for a process which requires heat, why don't *you* make it a production line operation? Calrod heaters are easy to install and require little maintenance. Whether your application is radiant heating, heating liquids, surfaces, air, pipelines, or melting soft metals, there is a G-E Calrod heater for the job. And recommendations of a G-E Heating Specialist may help you as they helped McCreary. WHY DON'T YOU present your requirements to the nearby G-E Sales Office, or write to *Sect. 720-51, General Electric Co., Schenectady 5, N. Y.*

*Registered Trademark

. . . the tenter frame. G-E Reactrol* Control keeps the speeding nylon web at the exact setting temperature . . . only 25 F below the fusion point.

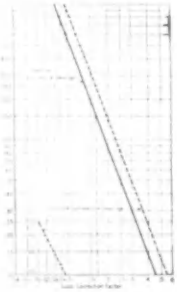
NEW SELLING AID

Gummed labels are now available to help tell your customers that your machinery is equipped with the best in "built-in heat" . . . G-E Calrod Heaters.

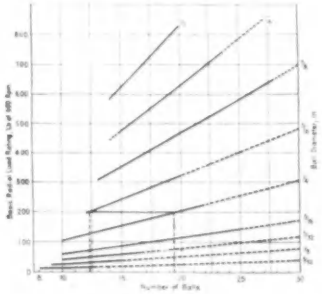
GENERAL ELECTRIC

720-51

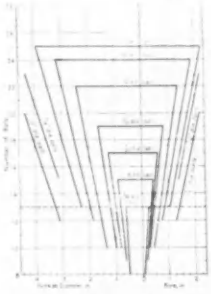
How to Reduce Your Bearing Costs



1. SPEED-LOAD CORRECTION: Find equivalent load rating of unground bearing by applying correction factors obtained from this chart. This is necessary since "Commercial" bearings are rated at 150 r.p.m.; correction factor is 1.65; equivalent load at 600 r.p.m. is 200 pounds.



2. LOAD RATING: Using equivalent load rating, find from graph above number of balls and diameter of balls required to handle equivalent load. For previous example, this demands 13 balls 5/16 in. in diameter, or 20 balls of ¼ in. in diameter.



3. BORE AND DIAMETER: Determine minimum outside diameter and maximum bore for selected bearings from this chart. The 13-ball 5/16 in. diameter ball bearing o.d. is 2 in., bore is 1-3/16 in. The 20-ball ¼ in. diameter ball bearing o.d. is 2¼ in., bore is 1¼ in.

ONE WAY TO CUT COSTS—without impairing product quality—is to take a close look at the possibilities of "Commercial" ball bearings in your design. Expensive precision bearings, made to extreme tolerances, are costly and often unnecessary for average anti-friction applications.

Schatz "Commercial" bearings, although low in cost, have, unless otherwise specified, carburized, hardened and tempered, high-grade steel races. High quality balls are used.

These bearings are available in metric dimensions; can be furnished with set screws, with seals and Alemite fittings, with hex bores, with inner and outer rings having various shaped grooves, threaded studs and other modifications. Composition treads of plastic or rubber can be specified.

A high-performance Schatz "Commercial" can economically replace bushings or plain sleeve bearings; eliminate costly machining and assembly time; improve product efficiency. It will pay you to look into Schatz possibilities in your product.

FOR EXAMPLE:

A Schatz bearing eliminated assembly rejects in a textile machine operating at 2,500 r.p.m. under a 20-pound load. The specially-designed "Commercial" had a split inner race and flanged outer race that replaced a slotted washer spot welded to a standard bearing. Result: one operation was cut out, and assembly rejects due to heat-distortion were completely eliminated.

An adjustable-width "Commercial" bearing designed by Schatz engineers helped an office-machine maker control bearing end-play on a typewriter carriage operating at 600 r.p.m. under a 12-pound load. The bearing is easy to mount, provides good rigidity. Its use simplified the machine design considerably.

Cost of "Commercial" bearings *decreases* in almost direct proportion to size; in high-precision bearings, cost *increases* as bore decreases.

IF YOU HAVE A FRICTION PROBLEM,
LET SCHATZ ENGINEERS DESIGN IT AWAY

THESE AND OTHER TABLES showing correct size and type "Commercial" Ball Bearings for various speed and loading conditions, and graphs for estimating bearing life, are included in "Construction and Characteristics of Low-Cost Ball Bearings." This technical booklet also discusses modifications that can be made for special design, assembly and operating conditions. Catalog No. 11 gives data on the complete Schatz "Commercial" line. Write for your copies today.

SCHATZ
"Commercial"
BALL BEARINGS

THE SCHATZ MANUFACTURING COMPANY · 6758 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.

The WHEEL: *One of man's earliest inventions*

FRICTION: *One of man's constant problems*

Solved...by applied research

Applied research, teamed with progressive engineering and production skills, lies behind the accomplishments of the automobile makers and their suppliers. The quality car of today is made in the millions each year. It's a far cry from the early automobiles of 1908, when production totaled only 63,500 cars.

Quality products demand quality suppliers. That's why Federal has been on the automotive team since 1915, supplying precision-built bearings. To progress in the automotive field, a company must measure up in research, engineering and production competence to strict standards.

Federal is meeting this challenge daily. The practically noiseless purr of a Federal Ball Bearing at work in hundreds of thousands of automobiles, machine tools, agricultural implements is silent proof of precision manufacture. It means painstaking care in production.

Federal quality—a byword in the precise automotive field—can be applied to your designs. Federal's precision-built bearings will improve your product's efficiency, life and performance. Write for Federal's 260-page catalog K today.

THE FEDERAL BEARINGS CO., INC., POUGHKEEPSIE, NEW YORK

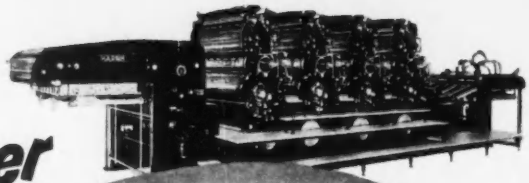
Makers of Fine Ball Bearings

Quality Since 1908

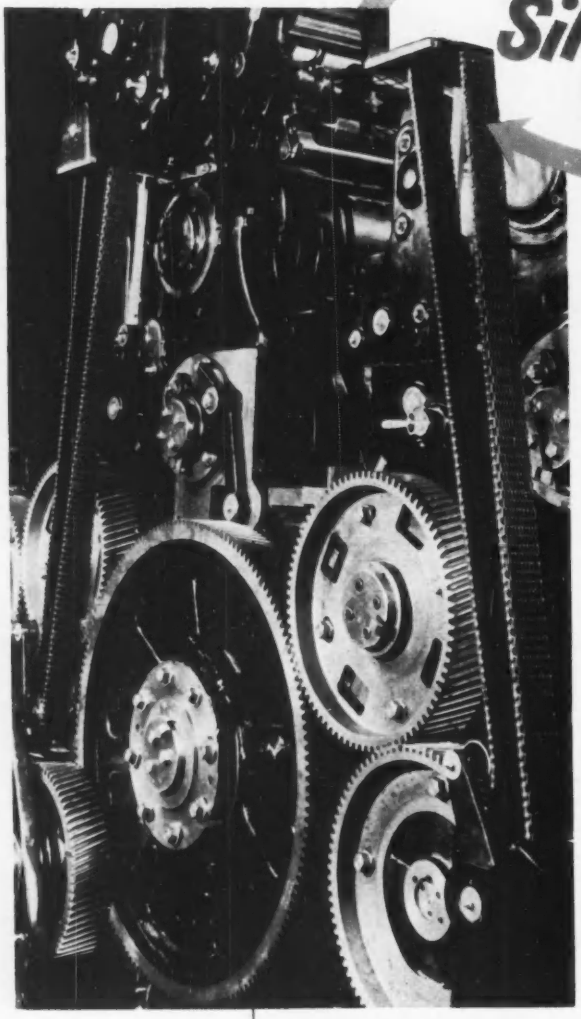
Federal BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

No Back Lash, Creep or Chatter



WHITNEY *Silent Chain* DRIVES



Transmit Smooth, Uniform Power, Provide Perfect Timing, Give Long Operating Life

Illustrated is the "Inker Drive" as used in the famous Harris Presses, manufactured by Harris-Seybold Co., Cleveland, Ohio.

In order to maintain perfect impressions, it is absolutely essential that this drive operate smoothly; back lash, creep or chatter cannot be tolerated as they would affect printing quality.

To obtain the perfect timing necessary and to get uniform power transmission for the all-important inking operation, Harris-Seybold Company uses Whitney Silent Chain Drives exclusively. Their experience over the past twenty years has proved conclusively that Whitney Silent Chain Drives transmit full power without friction or slippage . . . contribute to product reputation through real service performance.

In addition, Whitney Chain Drives are dependable drives . . . give long-lived service with minimum maintenance.

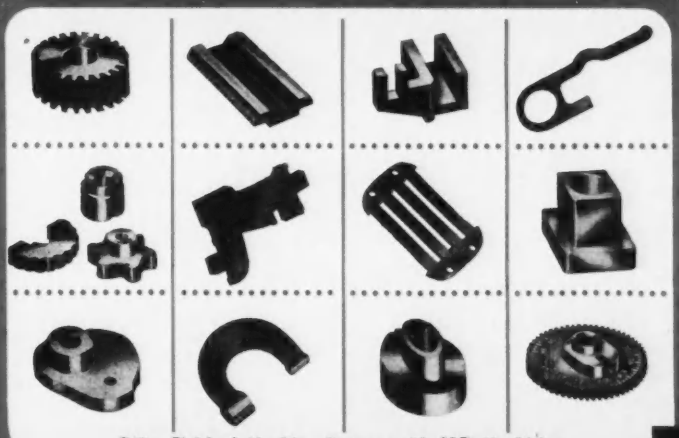
No matter what your drive problem, Whitney Chain Drives — Silent, Roller or Conveyor — *the all steel drives* . . . can help you simplify designs and cut power transmission costs.

Whitney Chain Company

204 HAMILTON STREET, HARTFORD 2, CONNECTICUT

NEED DEPENDABLE ALTERNATE MATERIAL including QUICK TOOL-UP and DELIVERY?

OILITE CAN HELP YOU NOW



Oilite Finished Machine Parts — with **NO** Machining

Here's how:

Oilite finished machine parts provide dependable replacements for bronze, brass, aluminum, cast iron, steel, and plastics. Frequently, replacements are permanent.

Oilite Material

Many Oilite raw materials, i.e., metal powders, are produced from by-products, readily available.

Tooling

Using Oilite finished machine parts, you save

- Tooling programs
- Tool Design
- Machine Tools
- Jigs and Fixtures
- Cutting Tools
- Gages
- Floor Space
- Skilled Manhours

Amplex type tools are, by comparison, inexpensive. Tool and die making facilities are available.

Delivery

Making Amplex tools generally requires only days or weeks and no additional machines.

Case Histories

Under conditions like today's we were in quantity production within six (6) weeks or less compared to eighteen (18) months by other processing.

Service

Our engineering and research covers a period of more than twenty (20) years in the production of Oilite metal powder products.

Home office personnel is augmented by a large staff of field engineers located in principal cities of the United States and Canada.

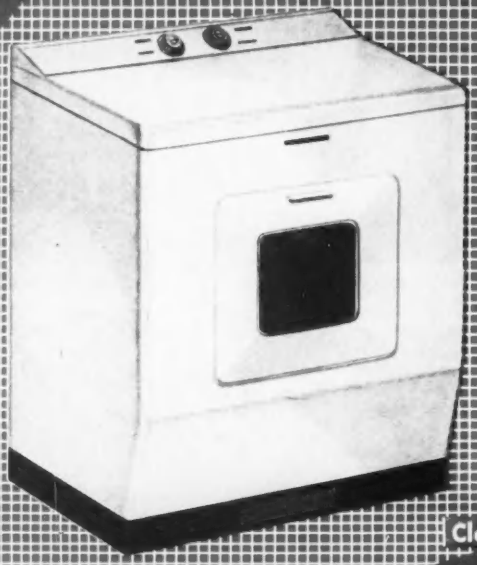
AMPLEX MANUFACTURING COMPANY
Subsidiary of Chrysler Corporation
DETROIT 31, MICHIGAN

OILITE PRODUCTS

OILITE PRODUCTS INCLUDE heavy-duty, oil-cushion, self-lubricating, ferrous-base bearings; Oilite bronze* and other nonferrous* bearings; self-lubricating cored* and bar* stock; permanent filters; and friction units.

Field Engineers and Depots throughout U.S. and Canada*

clothes dryers to deep fryers



wire cloth

FOR HOME APPLIANCES

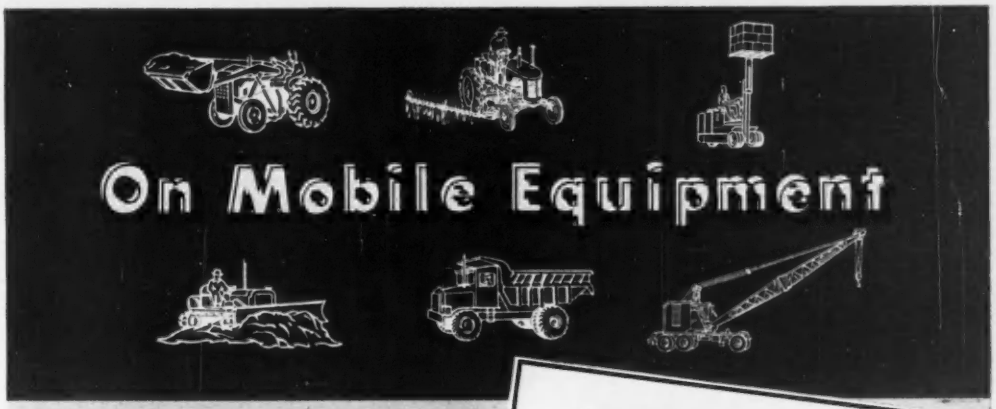
Whether the wire cloth is to be "standard" . . . or "strictly to specifications" . . . or a tough "start from scratch" new development problem—Reynolds engineers are right at home in the home appliance field. And in other fields—automobiles to aircraft . . . farm harvesters to fly swatters . . . floor furnaces to faucet filters. And for the same reasons—Reynolds' fifty years of fabricating wire, and many, many more years of research measured in engineering man-hours. If you use wire cloth, Reynolds engineers can be helpful. Consult them without cost or obligation.

- Clothes Dryers
- Automatic Washers
- Dishwashers
- Refrigerators
- Home Freezers
- Vacuum Cleaners
- Electric Ventilators
- Dehumidifiers
- Fruit Juicers
- Electric Deep Fryers

REYNOLDS WIRE DIVISION
NATIONAL-STANDARD COMPANY

DIXON, ILLINOIS

NS NATIONAL-STANDARD Company NILES, MICHIGAN



These Vickers Balanced Vane Type Pumps are especially designed and built for the severe service encountered with mobile equipment.

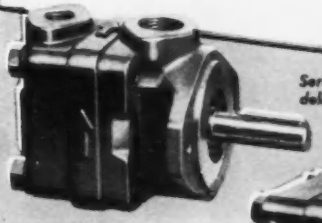
Their design automatically compensates for wear throughout pump life. Correct clearances are maintained continuously so that efficiency and delivery rate remain high. As a result, it is not necessary to select a larger pump to allow for loss of delivery under normal service conditions.

Hydraulic Balance . . . an exclusive feature of Vickers Vane Type Pumps for many years . . . eliminates pressure-induced bearing loads, providing longer life and less maintenance.

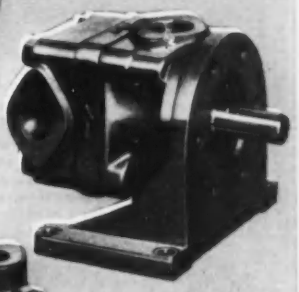
These Vickers Pumps are available in three basic sizes (shown at right) with a total of ten nominal delivery ratings and a variety of mountings. By unbolting and rotating the pump head the outlet may be placed parallel, opposite, or at right angle in either direction to the inlet. This greater adaptability to individual requirements means easy and inexpensive installation.

For additional information about these pumps (also double pumps) write for new Catalog M-5100. There is a Vickers Application Engineer near you who will be glad to discuss your hydraulic pump problems.

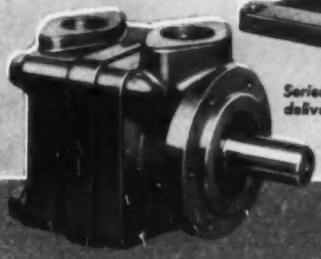
VICKERS BALANCED VANE PUMPS
Do a Better Job and Last Longer...
AT LOWER OVERALL COST



Series V-200 pump made in 4 delivery ratings—2 to 11 gpm.



Series V-300 pump made in 4 delivery ratings—12 to 24 gpm.



Series V-400 pump made in 2 delivery ratings—28 and 36 gpm.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH ROCHESTER • ROCKFORD • ST. LOUIS • SEATTLE • TULSA WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Ask for New Catalog M-5100

DO NOT LUBRICATE
Murderous shock duty is imposed on the motor on this log barker. Conventional cast motors broke shafts, feet, brackets. The steel frame Life-Line stands up . . . has reduced outages to zero . . . saved costly replacement.
FOR THE BEST DESIGN
USE Life-Line
WESTINGHOUSE
RESET
Other makes of starters, previously tried, couldn't "stand the gaff" on this cinder block-making machine. Here, where vibration is severe, standard Life-Linestarters performed without fail. Operation requires opening and closing of starter over 240 times every hour.

Jarred?

These two can take slam-bang abuse

How many times does your design call for something extra in a control . . . or a motor? Extra ability to withstand vibration, shock, physical impact, for example. Here's a pair—matched in ability to meet these conditions.

Take the Life-Linestarter.® Vibration or accidental impact does not cause false operation with resultant contact pitting. That's because it employs an inverted, clapper-type design in which a movable element is pulled against a stationary magnet. Contact opening does not depend on gravity. Positive kickout spring speeds operation.

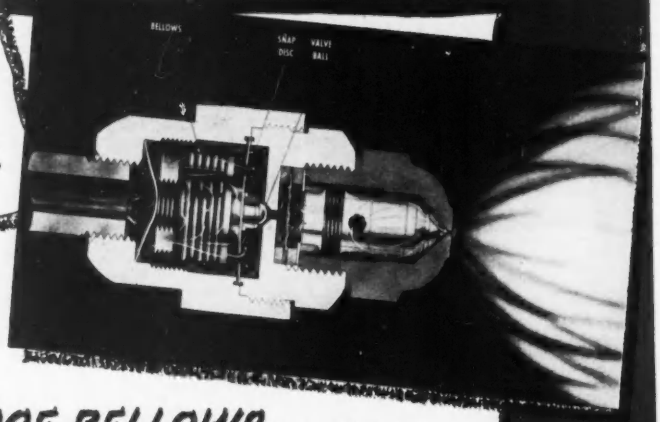
Now, the Life-Line motor. The severe stresses of heavy loads which must be transmitted through the motor frame and feet are easily withstood by the Life-Line steel frame. There's no distortion of laminations. What's more, steel adds strength without adding bulkiness. In fact, Life-Lines are as much as ⅓ smaller for the same frame size. You save space, weight; you gain strength.

Remember it costs no more to get Life-Line performance. Specify this pair on your future designs. More information? Simply call your Westinghouse representative. He'll give you complete facts . . . help you with any problems. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21626

YOU CAN BE SURE.. IF IT'S Westinghouse

Life-Line MOTORS and CONTROLS

In Minneapolis-Honeywell's new Dribble-Proof Burner Valve, oil is held back until pressure on the Clifford Bellows indicates proper atomization. Bellows then contracts, snapping open the valve ball for a cleaner, more efficient start. On the shut-down, the Bellows expands before pressure drops below the proper atomization point, snapping the valve ball shut, eliminating slow collapse of flame and leaving no oil dribble to foul up nozzle or electrodes.



It took a FLEXIBLE LEAKPROOF BELLOWS to actuate this new Dribble-Proof Burner Valve ... for Minneapolis-Honeywell

Reducing smoky starts and stops and a source of maintenance trouble in high pressure, gun-type oil burners, the Minneapolis-Honeywell Company's new dribble-proof valve features instant, positive control of oil flow.

That's why Minneapolis-Honeywell selected Clifford Hydron Bellows as the actuating mechanism. Immediately responsive to changes in pressure within the nozzle, these entirely leakproof, highly flexible bellows open and close the valve-ball seal so that not the slightest dribble of oil occurs before ignition or after shut-down.

Many Other Uses

Clifford Bellows have been selected by leading manufacturers for the widest range of applications. For example:

(1) Actuating switches or valves for accurate control of temperatures or pressures; (2) Sealing rotary shafts or packless valves against liquid or gas leakage; (3) Providing a flexible joint for instruments combining rotary motion and hermetic seal; (4) Transmitting motion hydraulically to remote points.

What Can They Do For YOU?

Be sure to use the coupon for our free booklet, describing the different types and functions of Clifford Bellows. You may discover, as so many others have done, that these dependable, accurate units can save you time, labor and money. And Clifford engineers will gladly make a confidential analysis of your sketches and specifications — any time, without cost or obligation.

CLIFFORD

HYDRAULICALLY-FORMED BELLOWS AND BELLOWS ASSEMBLIES

ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES

Free!

CLIFFORD MANUFACTURING COMPANY, 122 Grove Street, Waltham 54, Massachusetts
Division of Standard-Thomson Corporation
Sales offices in New York 17, Detroit, Chicago 1, Los Angeles

Please send me my copy of the bulletin "What to Consider When Selecting a Metallic Bellows". I am interested in the applications checked.

- ☐ Air conditioning systems
- ☐ Aircraft
- ☐ Carburetor altimeter controls
- ☐ Engine thermostats
- ☐ Gasoline valves
- ☐ High pressure steam devices
- ☐ Heating equipment
- ☐ Instruments
- ☐ Remote or direct control of temperature and pressure
- ☐ Compensating regulators
- ☐ Electric or gas ranges
- ☐ Kilns & ovens — industrial
- ☐ Air compressors
- ☐ Oxygen flow indicators
- ☐ Oxygen regulators
- ☐ Process controls
- ☐ Refrigerating systems — commercial
- ☐ Shaft seal assemblies
- ☐ Fuel pumps
- ☐ Fluid couplings
- ☐ Supercharger controls
- ☐ Refrigerator controls — domestic
- ☐ Torque converters

Other applications .....

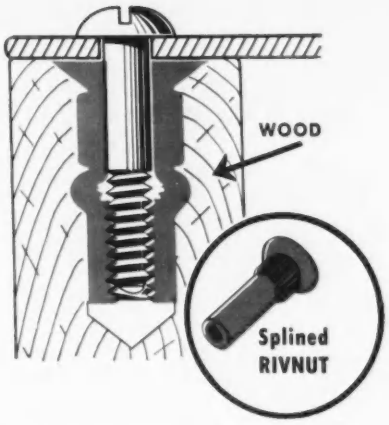
Name ..... Title .....

Firm .....

Street .....

City ..... Zone .... State .....

RIVNUT set in wood provides 6 clean threads for TV fastening job



Using wood screws to fasten the back of television sets is unsatisfactory because frequent removal of the screw quickly wears away the wood. This problem was solved for one leading manufacturer by splined Rivnuts. Imbedded and upset in the wood frame, Rivnuts provide at least six clean metal threads for screw attachment. Bulge formed by upsetting holds Rivnut fast. Splines take care of torque.

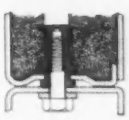
The splined Rivnut is only one of many types of Rivnuts that solve tough fastening problems in wood, metal, plastics, many other materials. Consult a Rivnut engineer for help with *your* fastening problem. The B. F. Goodrich Co., Dept. PE-121, Akron, Ohio.

What's your toughest fastening problem?

TORQUE?

Special Rivnuts with splined shafts or key (above) supply needed torque resistance.

SEAL?



Firm grip of upset Rivnut on material, plus special closed end, gives tight seal.

MATERIAL?

Even in thin materials, Rivnuts provide at least 6 threads for attachment.

ATTACHMENT?

Fasten *with* Rivnuts—fasten *to* Rivnuts. Makes possible multiple fastening.

FINISH?

Rivnuts can be installed after paint or porcelain finish is applied.

LOAD?

Typical Rivnut thread strength: 6-32—964 lbs.; 8-32—1096 lbs.; 10-32—1326 lbs.*

RIVNUTS *lick them all!*

***Figures given for aluminum. Loads for brass and steel Rivnuts about double.*

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Company, Department PE-121, Akron, Ohio.

Design your equipment

"We prefer U·S·S Cor-Ten," says Mr. Ross Castendyck of the Challenge Mfg. Co., Maywood, Cal., "because of its superior corrosion and abrasion resistance as well as its high strength. These permit us to reduce our Mixer weight 10%, to 15% and at the same time to build a 20% stronger unit that will stay in service at a lower maintenance cost."

U·S·S COR-TEN

U·S·S Cor-Ten is a ductile, low-carbon chromium-nickel-silicon-copper-phosphorus steel having a yield point of 50,000 psi min., and a tensile strength of 70,000 psi min. in thicknesses ½" and under.

Its resistance to abrasion and shock is superior to structural carbon steel; its fatigue resistance—that is, its ability to withstand repeated stresses—is 60% greater.

What particularly distinguishes U·S·S Cor-Ten is its unusually high resistance to atmospheric corrosion—4 to 6 times that of plain steel, 2 to 3 times that of copper steel. This property helps to assure the long life and low maintenance cost of any equipment in which Cor-Ten is used, whether to obtain greater durability or to reduce weight.

U·S·S Cor-Ten is produced in all standard products—plates, shapes, bars, sheets, strip, special cold formed sections and wire. Recommended particularly for application in light and intermediate thicknesses.

U·S·S MAN-TEN

U·S·S Man-Ten is a grade of manganese-copper steel that, at relatively low cost, provides toughness, workability and weldability in a higher degree than obtainable in carbon steel of the same strength level. Its atmospheric corrosion resistance is slightly higher than that of copper steel.

U·S·S Man-Ten, in thicknesses up to ½" inclusive, has a yield point of 50,000 psi min. and tensile strength of 75,000 psi min. Its abrasion resistance is greater than that of structural carbon steel (ASTM A7); its resistance to sudden shock is about 20% greater; its fatigue strength is approximately 40% higher, insuring greater ability to withstand vibration and reversal of stresses.

U·S·S Man-Ten is produced in plates, shapes, bars, sheets, strip, special cold formed sections and other forms. It is particularly recommended for use in light and intermediate thicknesses.

U·S·S Tri-Ten has long been used to assure the dependability for which Caterpillar equipment is famous. The weight-saving and space-saving advantages in proportion to the strength of this steel has resulted in their engineers using it regularly.

to meet today's requirements

Get more output, greater dependability and lower maintenance . . . by building with U·S·S HIGH STRENGTH STEELS

● With the Nation's productive effort of such vital importance, every piece of equipment you produce today has a tough job cut out for it. This is especially true of all construction, mining and transportation equipment. It will be required to do more work . . . do it faster . . . for long, continuous periods . . . and with increasingly less chance for replacement.

The more you can increase its capacity . . . the more you can speed it up . . . the easier you can make it to handle—the better. But it's even more important that you build it as strong, as dependable and as durable as possible. Structural failures that can put it out of service must be reduced to the absolute minimum. *You must give it the stamina to stay on the job.*

You can do it with U·S·S HIGH STRENGTH STEELS

With high-strength U·S·S COR-TEN, U·S·S MAN-TEN and U·S·S TRI-TEN, equipment breakdowns that hamper operations and run up costs can be greatly reduced. With these famous "steels that do more" you can build maximum strength and toughness in vital parts ordinarily prone to failure. With them, high resistance to wear, fatigue, abrasion and impact can be incorporated. And if your equipment must operate in sub-zero temperatures or under unusually corrosive conditions, high resistance to these destructive forces can readily be secured.

In addition, these U·S·S High Strength Steels—because they have a yield point 50% higher than ordinary structural steel—can be used to materially increase the strength of parts without increasing their weight. Or they can be used in lighter sections without in any way diminishing strength or stamina. In the latter case, *substantial savings in steel will result*. This is important now, with steel in restricted supply.

Our engineers for 16 years have cooperated with manufacturers in applying U·S·S High Strength Steels to construction equipment famous for its reliability, long life and low maintenance cost. They will be glad to show you how these tougher, stronger, more durable steels can be applied to give your equipment the stamina to stay on the job.

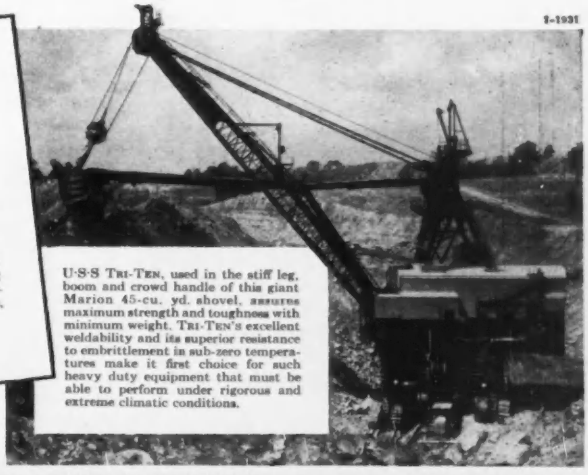
AMERICAN STEEL & WIRE COMPANY, CLEVELAND · UNITED STATES STEEL COMPANY, PITTSBURGH
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

9-1951

U·S·S TRI-TEN

This manganese-nickel-copper steel has a yield point of 50,000 psi min. and a tensile strength of 70,000 psi min. in thicknesses ½" and under, with moderately lower values as thickness increases to a maximum of 4". It has superior toughness and ability to withstand shock at sub-zero temperatures. It has greater resistance to abrasion than structural carbon steel (ASTM A7) and its fatigue resistance is 50% higher. U·S·S TRI-TEN'S resistance to atmospheric corrosion is slightly superior to copper steel.

Because U·S·S TRI-TEN has very good welding properties in intermediate and heavier thicknesses, this grade of U·S·S High Strength Steel is highly recommended for application in heavy duty equipment where maximum ruggedness and strength with minimum weight are prime requisites. Produced in plates, structural shapes, bars and bar shapes.



U·S·S TRI-TEN, used in the stiff leg, boom and crowd handle of this giant Marion 45-cu. yd. shovel, assures maximum strength and toughness with minimum weight. TRI-TEN'S excellent weldability and its superior resistance to embrittlement in sub-zero temperatures make it first choice for such heavy duty equipment that must be able to perform under rigorous and extreme climatic conditions.

USS

UNITED STATES STEEL

Illustrated: Model BP, single-pole, double-throw, 15A., 125V. A.C. Overall length 1⅝".

The only miniature snap switch

. . . where size and high rating come to terms with cost

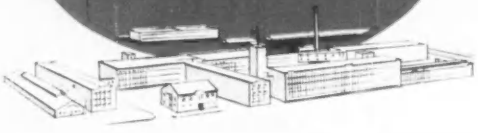
More and more, today's new products need the design forethought that assures quality performance *without increase in price*. And that's just where TYNISWITCH can help.

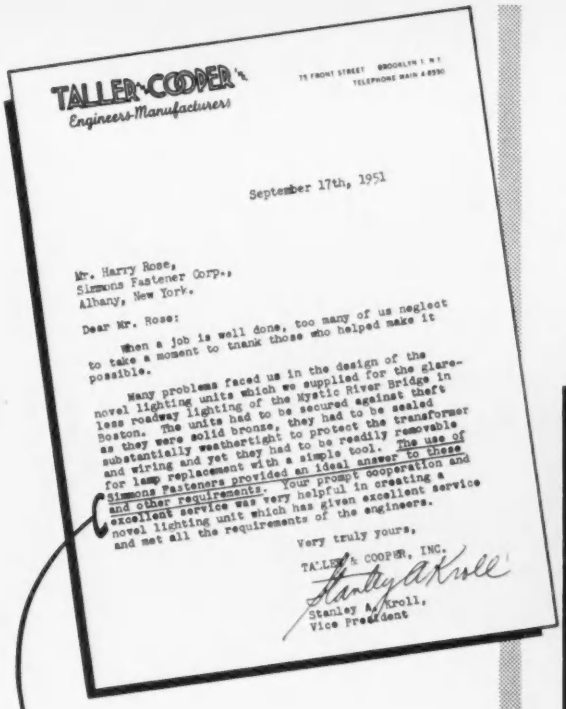
TYNISWITCH fills the need for high load switching in small spaces at lower cost than any other dependable miniature snap switch. Of special importance for many products is the specialized engineering service which develops new models for individual application requirements. This service offers an economical solution to your most difficult switching problems. Conventional circuit arrangements are available in a variety of standard stock models.

Investigate the advantages of TYNISWITCH. They add up to dependability and value unsurpassed in today's market. Write for details. TYNISWITCH Division, The Sessions Clock Company, 101 East Main St., Forestville, Conn.

Tyni Switch

A DIVISION OF THE SESSIONS CLOCK COMPANY, FORESTVILLE, CONNECTICUT





TALLER & COOPER, Inc.
Engineers-Manufacturers

75 FRONT STREET BROOKLYN 1, N.Y.
TELEPHONE MAIN 4-8590

September 17th, 1951

Mr. Harry Rose,
Simmons Fastener Corp.,
Albany, New York.

Dear Mr. Rose:

When a job is well done, too many of us neglect to take a moment to thank those who helped make it possible.

Many problems faced us in the design of the novel lighting units which we supplied for the glare-less roadway lighting of the Mystic River Bridge in Boston. The units had to be sealed as they were solid bronze, they had to be sealed substantially weathertight to protect the transformer and wiring and yet they had to be readily removable for lamp replacement with a simple tool. The use of Simmons Fasteners provided an ideal answer to these and other requirements. Your prompt cooperation and excellent service was very helpful in creating a novel lighting unit which has given excellent service and met all the requirements of the engineers.

Very truly yours,

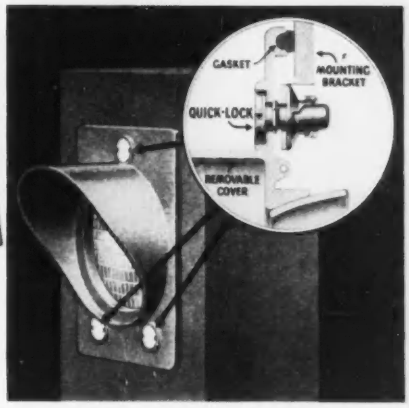
TALLER & COOPER, INC.

Stanley A. Kroll,
Vice President

"The use of Simmons Fasteners provided an ideal answer"

Getting the *right* answer—engineering and production-wise—is the day-by-day business of Taller & Cooper, Inc. This engineering and manufacturing company has produced many unusual designs for power control, wind tunnels, computers, automatic weighing and toll-bridge structures. Taller & Cooper engineers, in developing the sealed-beam lighting for the Mystic River Bridge, Boston, Mass., found the right answer in Simmons QUICK-LOCK.

Have you a similar fastening problem?



Unusual design by Taller & Cooper solves a number of problems in highway lighting. The engineers use a conventional sealed-beam headlamp mounted in an adjustable bracket. A cast bronze cover plate with integral visor is attached with three Simmons QUICK-LOCK fasteners to the housing which is part of the bridge structure. A rubber gasket seals the assembly.

Servicing is simple because QUICK-LOCK opens or locks with a 90-deg. turn. Inspection is easy because the stud is self-ejecting when it isn't locked. QUICK-LOCK keeps the gasket compressed tightly. The special head makes the unit tamper-proof. The fastener also resists vibration.

QUICK-LOCK can provide your design with unusual plusses, too. Simmons' engineers will be glad to study your fastening problems.

SIMMONS FASTENER CORPORATION
1751 North Broadway, Albany 1, New York

Simmons

LINK-LOCK . . . QUICK-LOCK . . . SPRING-LOCK . . . ROTO-LOCK

FASTENERS WITH USES UNLIMITED

BELVEDERE BOWL— with Griptite* base developed by Goodyear. Design meets precision requirements for dimensions, hardness, resistance to fats and oils. Note metal valve insert bonded to rubber base.

Business as Unusual

THANKS TO GOODYEAR PRECISION-MOLDED RUBBER

AN unusual product that may show YOU the way to a new or better design is the Belvedere Mixing Bowl, with its Griptite base that lets a woman use both hands for kitchen mixing.

Problem here was to mold a rubber base that would hold a mixing bowl to the kitchen counter. It required an airtight seal that would hold even under the stress of stirring, yet be instantly releasable. The answer was *precision molding*—the kind of work that characterizes all the output of Goodyear's Molded Goods Plant at St. Marys, Ohio.

Whether you need simple parts or complex shapes—molded or extruded, compounded to meet specific requirements—you can be sure of exact, uniform quality and performance, thanks to advanced production techniques, rigid inspections and controls at this plant—world's largest devoted to producing molded and extruded items from rubber and the new rubber-like plastics.

If you have a design or production problem rubber may solve, turn to the G.T.M.—Goodyear Technical Man—or write direct to Goodyear, Molded Goods Dept., St. Marys, Ohio.

MIX—WITHOUT HOLDING
—rubber base enables bowl to adhere to any smooth surface—lets women mix without holding bowl, frees other hand for pouring.

We think you'll like
"THE GREATEST STORY EVER TOLD"
Every Sunday—ABC Network

*Griptite—T.M. Griptite Corporation, Lancaster, Ohio

GOODYEAR

THE GREATEST NAME IN RUBBER

Designers:

What can you do with this new U·S·S Stainless Steel?

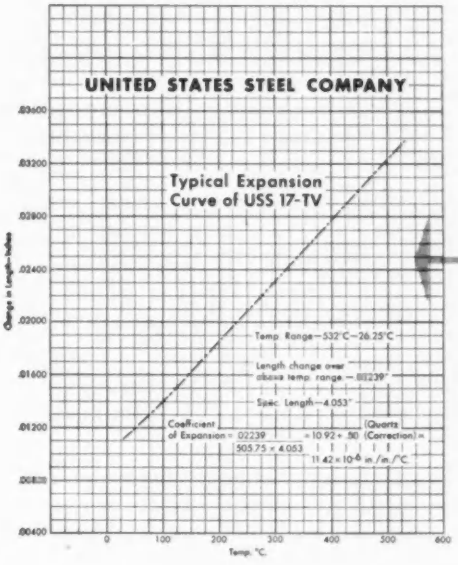
IF you are designing products that require a tight glass-to-metal seal, it will pay you to investigate thoroughly the properties of U·S·S 17-TV Stainless Steel.

This new metal is basically a 17% chromium Stainless Steel, possessing a coefficient of thermal expansion that permits vacuum-tight glass-to-metal seals. Developed especially for and used widely in television picture tubes, U·S·S 17-TV offers great promise in a variety of similar applications.

In television picture tubes, this new U·S·S Stainless functions as the body portion of the tube. A face plate of special drawn glass, with a coefficient of expansion of about 10 x 10^{-6} °C between 500° and 25°C., is sealed into the large end of the shell. A glass neck funnel of industrial type glass, with a coefficient of expansion of 9.5 x 10^{-6}/°C, is sealed to the small end of the Stainless Shell.

U·S·S 17-TV meets the requirements of the proposed ASTM Specification for 17% Chrome Iron Alloy for Sealing to Glass which states in part that the metal must not exceed a coefficient of thermal expansion of 11.7 x 10^{-6}/°C after first heating to 1200°C and measuring the contraction between 530° and 30°C.

U·S·S 17-TV is sold today primarily in sheets ranging in thickness from .090" to .125", but inquiries are welcomed on other sizes and forms. In the fabrication of television tubes, U·S·S 17-TV is spun or formed from flat blanks.



Examine the expansion curve of a typical heat of U·S·S 17-TV Stainless Steel shown here. If you see possibilities for its use in your design and wish to investigate it more thoroughly, write on your company letterhead for a laboratory sample (size, 8" x 10"; gage, .100"). Send your request to United States Steel Company, Room 4302, 525 William Penn Place, Pittsburgh 30, Pa.

This Dumont 30" picture tube, largest ever made for home viewing, has a shell of U·S·S 17-TV Stainless Steel, vacuum-sealed to glass face plate and neck assembly.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · COLUMBIA STEEL COMPANY, SAN FRANCISCO
NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, FAIRFIELD, ALA. · UNITED STATES STEEL COMPANY, PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

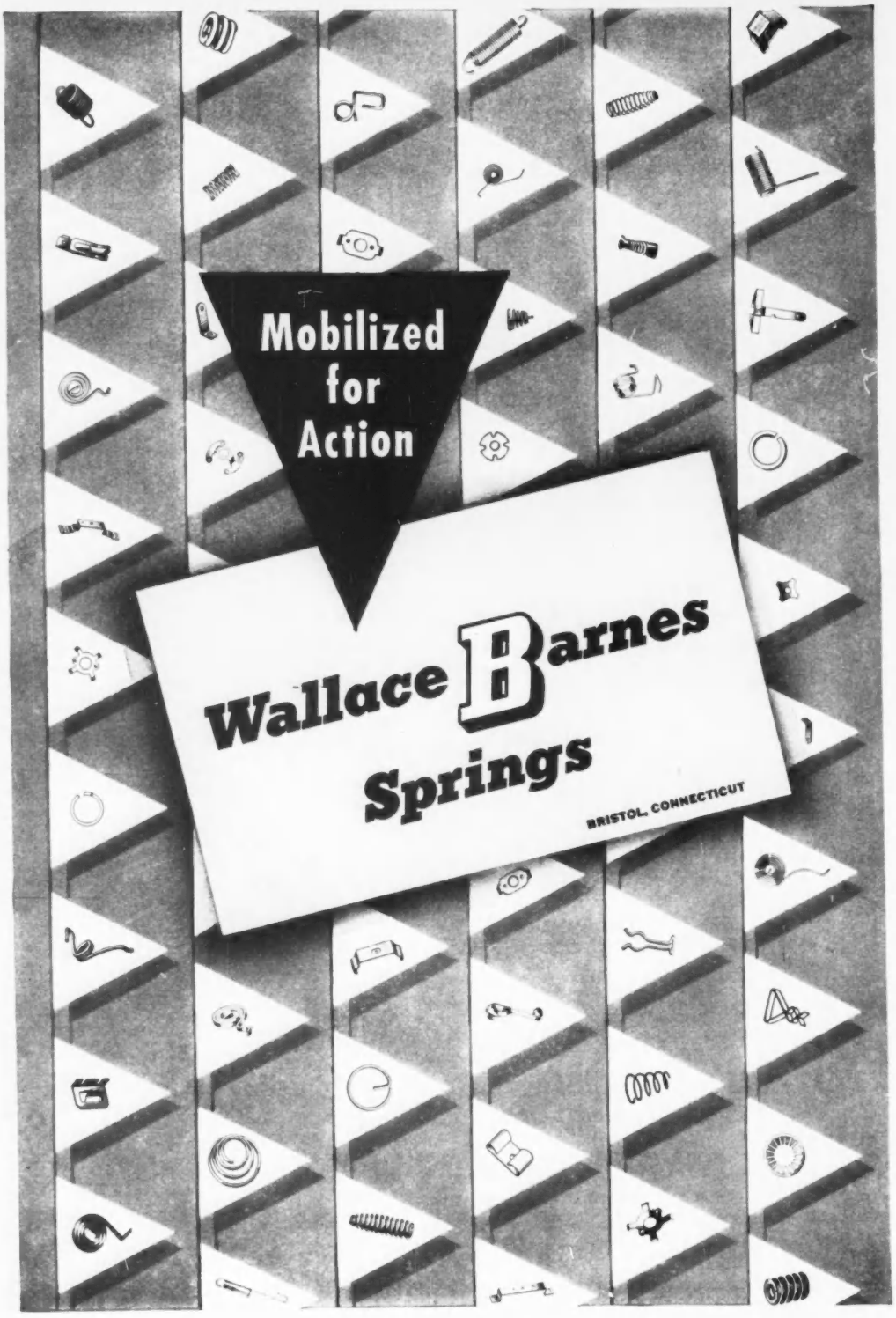
USS TRADE MARK

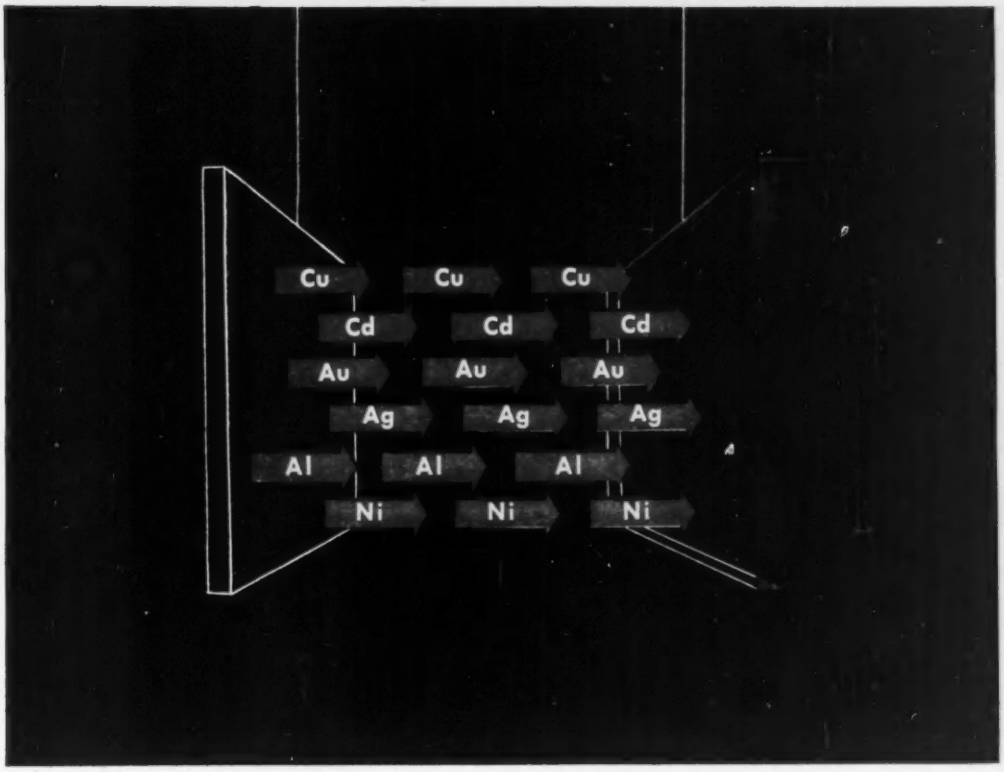
U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

1-1674

UNITED STATES STEEL


Mobilized
for
Action
Wallace Barnes
Springs
BRISTOL, CONNECTICUT



YOU'RE INVITED TO THIS WEDDING!

The union of plastics and metals is taking another new form today! Both BAKELITE Phenolic and Styrene Plastics are now being electroplated with copper, cadmium, gold, silver, aluminum, nickel, brass, tin, and other metals. Thus, great new strides are made in combining the desirable properties of metals with the equally useful characteristics of plastics—at low cost, and with notable conservation of critical materials.

Since plastics ordinarily do not conduct electricity, a way had to be found to form a conductive coating. The trick is turned by first roughening plastic parts, then dipping them in a chemical sensitizer. This is followed by application of a thin bond coat of silver by means of chemical reduction in solution.

Actual electroplating begins here. On the outside of perforated drums revolving in a special electrolyte, copper anodes furnish ions which migrate through the holes in the drum to the parts tumbling inside in contact with electrodes in the drum base.

Silver, gold, tin, or other metals are firmly and permanently plated on the resulting copper plate. After a final buffing, the high polish and long-wearing smoothness of the metals are advantageously wedded to the lightweight and corrosion resistance of plastics.

An interesting and useful stage of the plastic-plating process permits many variations in the final color of the products.

Many industries are studying the results intently. Perhaps yours will be one to benefit most. Write Dept. CS-10.

Data furnished by Plastiplate Co., Inc., South River, N. J.

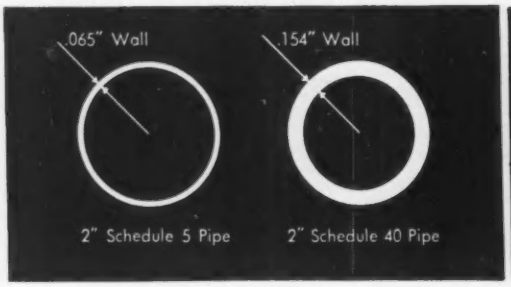
BAKELITE
TRADE MARK
PLASTICS

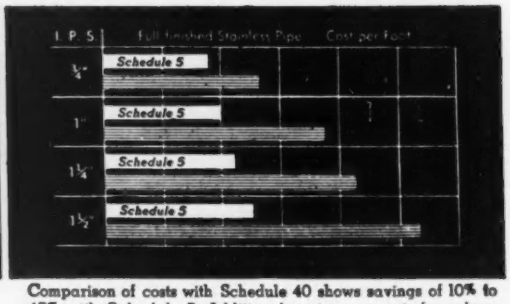
TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N.Y.

how *Carpenter* is helping industry get more stainless pipe

—even today, when it's tough to get!





Comparison of costs with Schedule 40 shows savings of 10% to 45% with *Schedule 5*. Additional savings on costs for valves, fittings, etc. are also possible.

What Carpenter *Schedule 5* Pipe Is—

Its LIGHT WALL gives *more feet of pipe* for every pound of Stainless Steel. Cost is 40% to 50% lower. Larger I.D. increases flow area and permits use of a smaller pipe size.

You now have a way to help us improve the availability of Stainless Pipe for essential uses. And you can do it at a terrific saving in your costs.

You can hook up *Schedule 5* Pipe with existing lines of tubing or heavier wall pipe, Schedules 10 and 40.

For most jobs Carpenter *Schedule 5* Stainless Pipe handles the working pressures with a good margin of safety. Any working pressure up to 150 psi is handled by this pipe. In pipe sizes under 1½", higher pressures are frequently used.

More Stainless Pipe for essential uses is possible, even under today's conditions. To get the full story, call your nearest Carpenter Stainless Tubing Distributor. Or, write for a copy of the new "*Schedule 5* Data Sheets". We will be glad to send you a set.

THE CARPENTER STEEL COMPANY
Alloy Tube Division, Union, N. J.
Export Department: Carpenter Steel Co., Reading, Pa.—"CARSTEELCO"

Carpenter
STAINLESS TUBING & PIPE

- guaranteed on every shipment

Lubrication's sure and easy on Rocker Arm Straightener

Multival Centralized System is standard equipment

USERS of this Impco rocker arm straightening machine are pleased with its smooth, trouble-free operation. Lubrication is no problem because every machine is equipped by the manufacturer with a Multival Centralized Lubricating System.

Multival is simple, streamlined and efficient—low in cost, easy to install and easy to operate. There is no fuss, no muss, no waste, no burned out bearings, no shutting down the machine for lubrication.

A man with a grease gun makes one connection at the Multival Block. With a single stroke, he fills all the measuring valves, which at the same time deliver an exactly measured quantity of oil or grease to each bearing served by the system. The system can be operated as often or as seldom as necessary, and the amount of lubricant delivered is adjustable to each individual bearing need, so that no bearing gets too much or too little.

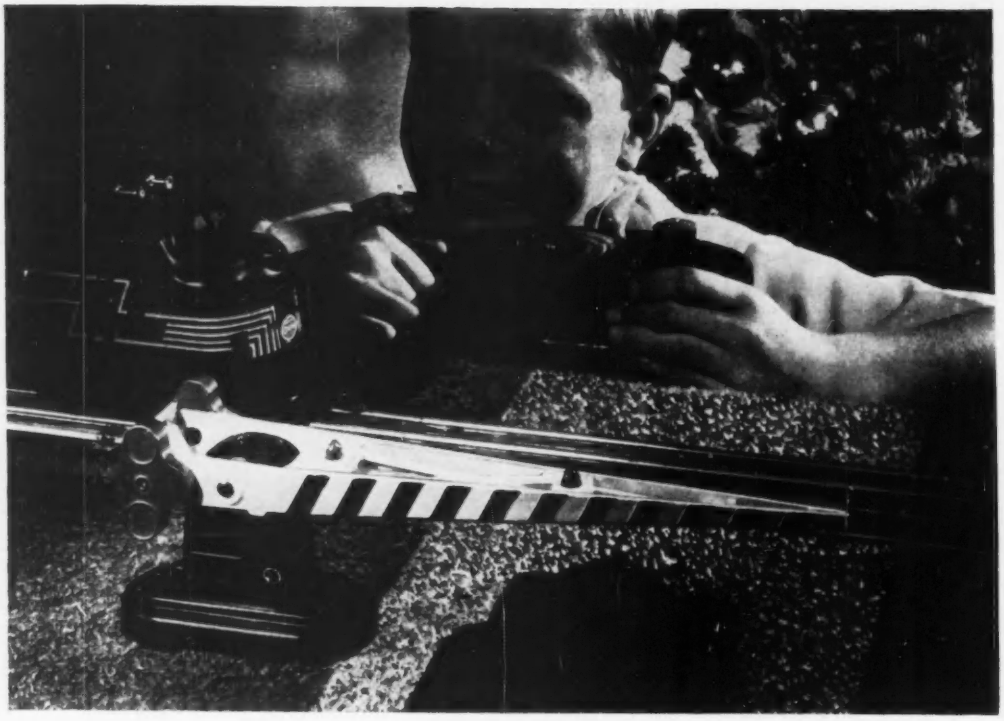
Multival is a Farval-engineered product, incorporating the unique Farval valve and piston design. The Farval valve is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Wide valve ports and full hydraulic operation insure unfailing delivery of grease or oil to each bearing—as much as you want, exactly measured—as often as desired.

Write for Multival Bulletin 15 or Farval Bulletin 25. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

● *Greasing this rocker arm straightener takes only a few minutes, because it is Multival-equipped. For larger machines for straightening crankshafts, this machinery builder, Industrial Metal Products Corporation of Lansing, Mich., has standardized on Farval Centralized Systems of Lubrication.*

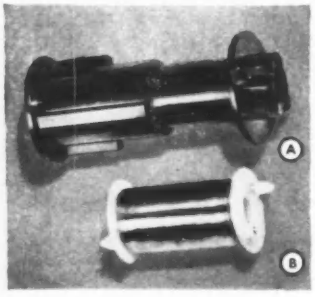
FARVAL—*Studies in Centralized Lubrication* No. 125



NYLON PLASTIC GATE HOUSING BUILT TO LOOK LIFELIKE . . . LAST A LIFETIME

Lionel gets realistic detail, outstanding durability, and heat-resistance in gate housing and other parts molded of Du Pont nylon

If you have ever seen the Lionel model railroad trains and accessories, you know why they are justly famous for toughness and detailed accuracy. So, when Lionel designed this realistic crossing gate, they used Du Pont nylon plastic for the housing, which encloses the electrically operated mechanism and a 10-watt light bulb. Nylon withstands continuous heat up to 250°F.—more than is encountered in normal use, enough to insure satisfactory performance under extreme emergency conditions. Furthermore, durable nylon easily withstands the rough treatment that this toy is bound to receive. And nylon is readily molded to accurate detail . . . even to the tiny bolt heads which add realism.



(A) CONCENTRIC SPLINE SHAFTS used in new Lionel transformer. Typical of new designs in which Lionel has used a nylon part to replace numerous combined parts made of other materials.

(B) COIL FORM (inside gate housing) resists continuous heat up to 250°F. Molded in extremely thin sections, it will not break in winding operation . . . serves as its own bearing. One of many coil forms used in Lionel equipment.

Lionel uses nylon in many other parts —some for nylon's strength in thin and intricate sections . . . some for nylon's electrical insulating properties . . . some, like the above part, for nylon's superior heat-resistance.

Why not investigate molded nylon parts for improving your product and its production? For additional information on nylon and other Du Pont plastics write:

E. I. du Pont de Nemours & Company (Inc.)
Polychemicals Department, District Offices:
350 Fifth Avenue, New York 1, New York
7 S. Dearborn St., Chicago 3, Illinois
845 E. 60th St., Los Angeles 1, California

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

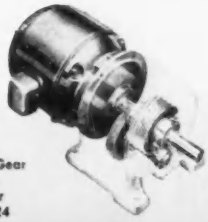
No one speed reducer solves every reduction problem

That's why LINK-BELT builds all 3

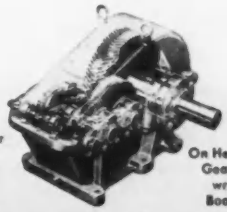
WHETHER it's a helical, a herringbone or worm gear drive that best fits your needs—you get an unbiased recommendation, an incomparable product from your Link-Belt power transmission engineer.

That's why Link-Belt builds all three; has no axe to grind. You can be sure you get the one that suits all your requirements for ratio, space, shaft position, shock loading and many other factors. Precision-engineered for quiet, economical power transmission, all Link-Belt drives will give you long service under the toughest operating conditions.

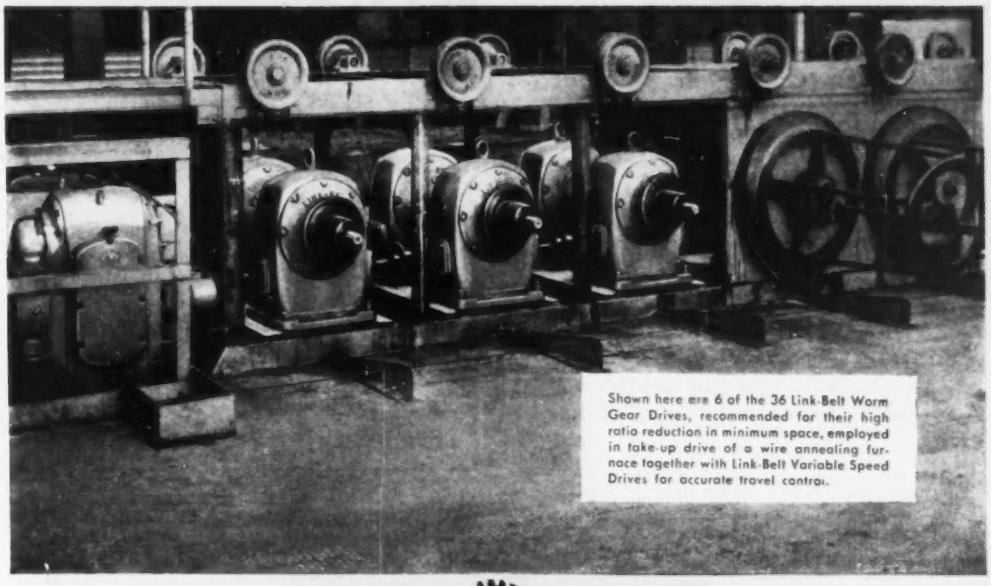
On Worm Gear Drives write for Book 2324



On Gearmotor and Helical Gear Drives write for Book 2247



On Herringbone Gear Drives write for Book 2419

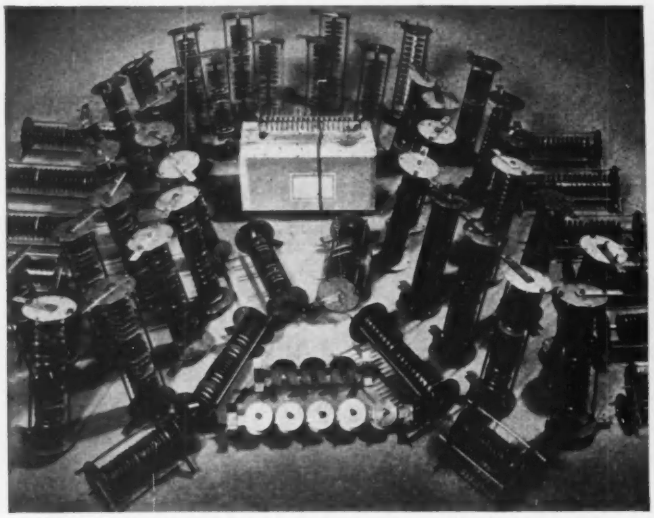


Shown here are 6 of the 36 Link-Belt Worm Gear Drives, recommended for their high ratio reduction in minimum space, employed in take-up drive of a wire annealing furnace together with Link-Belt Variable Speed Drives for accurate travel control.

LINK-BELT ENCLOSED GEAR DRIVE

12,239

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in Principal Cities.



SPOOL-TYPE SPECIMEN HOLDERS permit testing several materials under service conditions without risk of mechanical damage. Specimens make no contact with each other or with plant equipment . . . thus, galvanic effects are prevented.

ASSEMBLING A CORROSION TEST SPOOL. Specimens are machined to specified dimensions, and expose exactly 0.5 sq. dm. when mounted for test.

Help for solving your INDUSTRIAL CORROSION PROBLEMS...

Available for solving your specific problem is a vast amount of information on industrial corrosion.

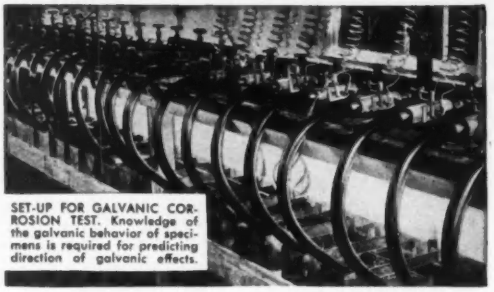
Acquired and catalogued by The International Nickel Company's Corrosion Engineering Section, this fund of data is constantly being increased.

Valuable information is obtained in various ways...for instance, by cooperative field tests in which specimens are exposed to actual plant operating conditions. Also, by fundamental investigations in the laboratory and by tests that duplicate, so far as practical, existing or expected conditions where plant tests are impractical.

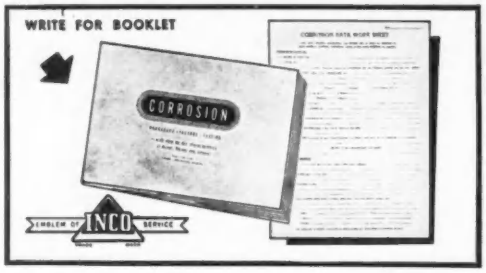
A great deal of important data comes from INCO's large scale marine testing stations at Kure Beach and Harbor Island, and from stations having industrial and rural atmospheres. In addition, technical literature, reports, and manufacturer bulletins contribute useful information.

Our files contain data from more than 2,000 plant tests on some 40,000 metal and alloy specimens. All information is tabulated on standard forms, and a punch card key sort system facilitates finding specific data.

We freely provide the Corrosion Data Work Sheet, illustrated, for presenting your specific problems.



SET-UP FOR GALVANIC CORROSION TEST. Knowledge of the galvanic behavior of specimens is required for predicting direction of galvanic effects.



Whenever you need assistance in solving a corrosion problem, our Corrosion Engineering Section will gladly cooperate with you. A free copy of the new booklet entitled "Corrosion" may help you defeat corrosive attacks...write for it now.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

"Mopping up" for momma

If your wife has one of the popular, new O'Cedar Cellulose Sponge Mops, take a good look at it. You will note that the cellulose sponge is bonded to a piece of canvas, which in turn is bonded to a metal plate. In each case, a 3M adhesive is used.

Working closely with O'Cedar engineers, 3M developed an adhesive specifically for their application. The adhesive had to be highly resistant to soaps and detergents, boiling water, and plain, old-fashioned "elbow grease." Moreover, the adhesive had to fit production line methods that turn out thousands of high quality mops, at low cost. The success of this adhesive—proved by manufacturer and consumer—is another tribute to the almost limitless versatility of 3M adhesives.

Scientifically engineered to each job, 3M adhesives, coatings and sealers are cutting costs, speeding production and improving products daily . . . in all industries!

See what adhesives can do for you . . .

Contact your 3M salesman. His expert advice is at your disposal. And for more information on adhesives, coatings and sealers, write 3M, Dept. 412, 411 Piquette Avenue, Detroit 2.

3M COMPANY

OVER 1,000 BASIC

ADHESIVES · COATINGS · SEALERS

ADHESIVES AND COATINGS DIVISION • MINNESOTA MINING AND MANUFACTURING COMPANY
411 PIQUETTE AVE., DETROIT 2, MICH.
GENERAL OFFICES: ST. PAUL 6, MINN.
EXPORT AND CANADIAN SALES: 270 PARK AVE., NEW YORK 17, N. Y.

short cuts to savings for you!

Custom-made

SYLPHON *STAINLESS STEEL* BELLOWS ASSEMBLIES

NO MATTER how "tricky" a bellows assembly you may require, we can make it for you—save you time and money, too.

You get the advantages of trained personnel—specialists in this highly specialized field. They're backed by half-a-century of experience in developing and producing bellows assemblies of all kinds.

You get service that saves you time. We take over all production problems and worries—see that you get bellows assemblies made *exactly* to your specifications, *on schedule.*

If you use, or plan to use, stainless steel (or other metal) bellows assemblies—for thermostatic devices, pressure controls, hydraulic mechanisms, recording instruments, valves or other applications—we can show you short cuts to savings. Write either Fulton Sylphon Division or Bridgeport Thermostat Division. Ask for idea-stimulating catalog XP-1200.

TEMPERATURE CONTROLS

FULTON SYLPHON
DIVISION
Knoxville 4, Tenn.

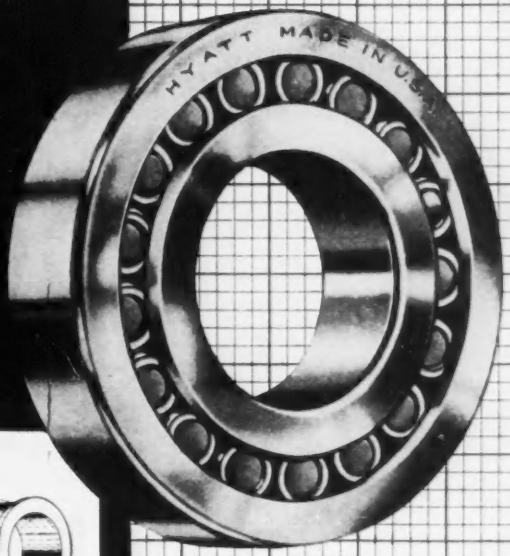
Robertshaw-Fulton
CONTROLS COMPANY

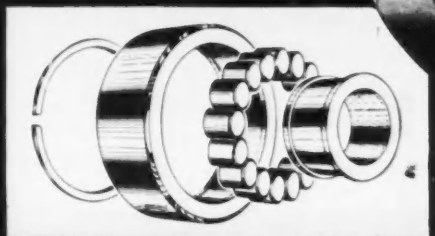
BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.

A High Capacity Full Complement Bearing...

HYATT HY-LOAD





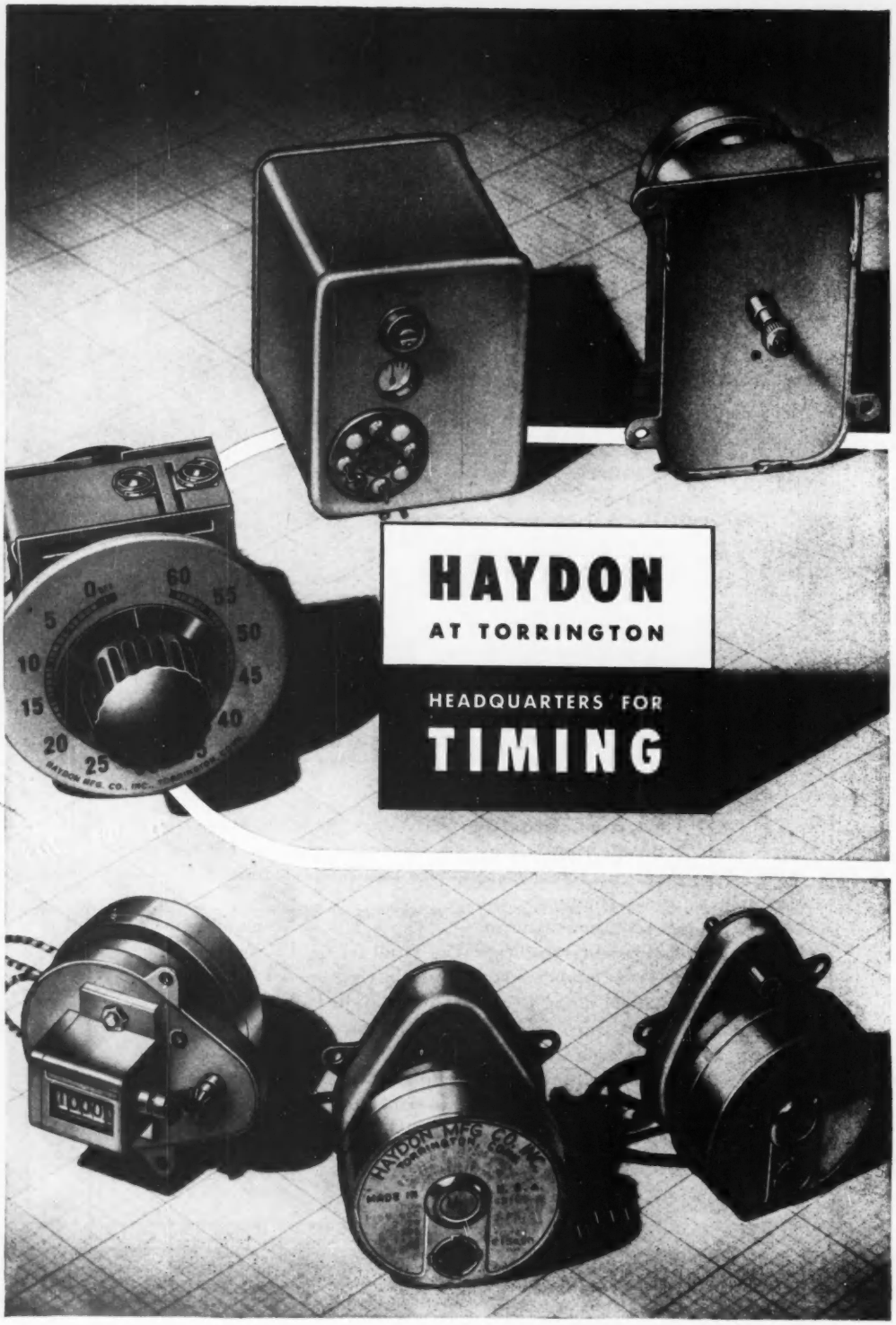
THE U-YM type of Hyatt Hy-Load Roller Bearing is non-separable, with a full complement of rollers for maximum capacity, and flanged race construction to permit these bearings to locate the shaft endwise or accommodate light or intermittent thrust in one direction. Used in pairs, they can locate the shaft in both directions or carry light thrust from either direction.

The non-separable types of Hyatt Hy-Load Bearings, such as the U-YM, are made for applications where the bearings must be assembled as a complete unit.

* * *

The U-YM, or some other type of Hyatt Hy-Load Bearing may be just the right one for your machine design. Write for your copy of Catalog 547 for complete information about the Hy-Load line of Hyatt Roller Bearings. We will be glad to send one to you. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS


HAYDON
AT TORRINGTON
HEADQUARTERS FOR
TIMING

TIMING MOTORS

HAYDON* timing motors offer many advantages. Slow rotor speed allows minimum of gearing for various output shaft speeds providing quiet operation and long life. Unusually small size. Motors totally enclosed. Controlled lubrication with separate rotor and gearing lubricating systems permits selection of best method and lubricants. Operates continuously in any position. Simple to mount securely. Interchangeable design in only 2 motor series with standard speed range from 60 rpm to one revolution in 7 days. Write for Motor Catalog.

400 CYCLE MOTORS and TIMERS

FOR MILITARY APPLICATIONS

HAYDON research and engineering staffs constantly seek to develop new and build better products. One example is the HAYDON 400 cycle timing motor. This is an hysteresis type synchronous timing motor, for use as a separate motor or in many different types of timers. HAYDON personnel and plant are equipped to build motors and timers using D.C., 60 cycle or 400 cycle for military or civilian applications. Write for Engineering Bulletin No. 2 for complete information on the 400 cycle motor.

TIMING DEVICES

HAYDON specializes in the manufacture of timing components for standard applications and also in the design and mass production of custom-engineered timers for volume applications. The basic element of all HAYDON timers is our own rugged industrial motor described above. This means that HAYDON timing devices can be depended upon to give long, quiet operation. They are small and compact and offer designers unusual latitude in that they may be mounted and will operate without interruption in any position. Write for Device Catalog.

HAYDON Manufacturing Co., Inc.

SUBSIDIARY OF GENERAL TIME CORPORATION

3136 ELM STREET, TORRINGTON, CONNECTICUT

MAKER OF CONVEYORS USES

Cold-Formed Shapes

FOR SIDE FRAMES

This $3\frac{1}{2}$ in. x $1\frac{1}{4}$ in. x $1\frac{1}{4}$ in. channel is used as a side frame by a maker of roll- and wheel-type conveyors. We make it from 10- or 11-gage SAE 1010 sheet steel, and furnish it to the manufacturer in straight lengths.

Side frames for mechanical conveyors are but one of a long list of practical uses for Bethlehem Cold-Formed Shapes. These versatile shapes are currently being used in such interesting applications as supports for telephone switchboards, parts for aircraft engine containers, side-plate sections for railway refrigerator cars, track sections for garage doors, and frames for window screens. And the list of additional uses is as varied as it is long.

Bethlehem Cold-Formed Shapes are regular or irregular shapes formed cold from strip, sheet or plate steel. They are uniform in thickness. Their surface is relatively free from scale. They have an ideal strength-to-weight ratio. We make them on presses, brakes or rolls in all gages from 5 to 24, and in virtually any length.

Ask the nearest Bethlehem sales office for a copy of our booklet on Bethlehem Cold-Formed Shapes.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

LINK-BELT Ball and Roller Bearings smooth the path of power

Lubrication fitting with pressure relief feature prevents excessive grease pressure.
Spring-locking collar with set screws clamps bearing firmly on shaft.
Lubricant passes freely into large reservoir to lubricate moving surfaces.
Self-aligning seals effectively keep grease in and dirt out, regardless of alignment.
Wide inner ring distributes bearing load over large shaft area.
Universally aligning. Capacity for radial thrust loads.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set screws in locking collar.
Sturdy, compact cast housing requires minimum support space.
Slotted bolt holes facilitate mounting on supporting structure.
CUTAWAY OF SERIES 200 BALL BEARING PILLOW BLOCK

By any standard . . . **LINK-BELT Bearing Blocks protect and lubricate all moving surfaces**

To give you longer bearing life and extended lubricating schedules, Link-Belt Ball and Roller Bearings are Housing-Sealed — all moving surfaces are completely enclosed and centrally lubricated from a large common reservoir. And only from Link-Belt do you get this important advantage on ball as well as roller bearings. There's a Link-Belt Bearing Specialist near you. Or you can get full engineering information in Data Book 2550.

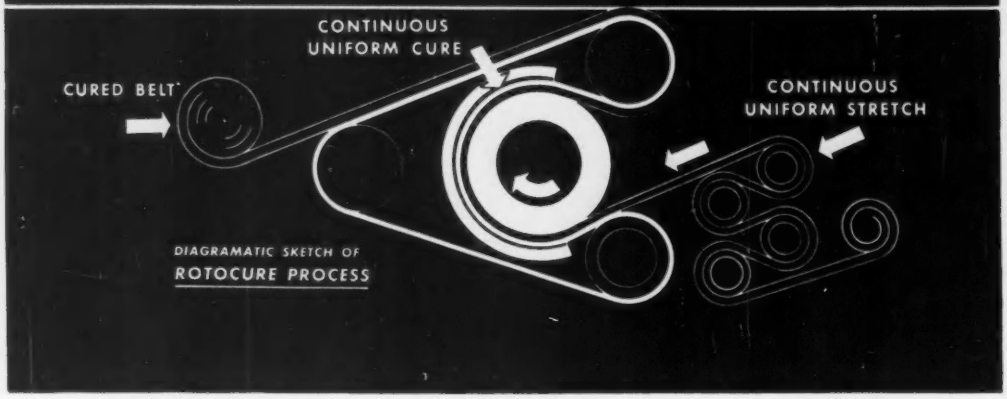
12,383

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities.

They're CONTINUOUSLY Right!



(No "Start and Stop" Curing--No OCS* with BWH ROTOCURED Belts)

In industry, attaining uniformity of product is a primary objective of those who buy and those who sell. *But you can't get it in conveyor belts made by conventional flat press methods!*

WHY CONVENTIONALLY-MADE BELTS ARE VULNERABLE

In flat press curing, overcured segments due to press overlaps occur every 30 to 40 feet. These segments (2" to 4" wide across the entire belt) result because vulcanization is not continuous — sections cured earlier advance less than a full press length. The weakened structure due to overcuring invites operational weaknesses and is a major reason for early belt failure.

WHY ROTOCURE ELIMINATES THIS CAUSE OF FAILURE

As the accompanying diagram shows, BWH ROTOCURED CONVEYOR BELTS are made by a continuous, endless curing process. Weak segments due to overlapping can't *happen* because the belt is in constant, uniform motion.

WHY ROTOCURE PAYS OFF IN DOLLARS AND CENTS

Inherent in the Rotocure process are these 4 specific advantages:

(1) Increased belt flex life — as much as 40%.
(2) Elimination of mechanical distortion at the press ends.
(3) Constant, uniform stretch.
(4) Uniform, abrasion-resistant covers.

These advantages are giving BWH Conveyor Belt users longer life per belt, lower belt maintenance costs and worthwhile savings per ton in materials conveyed. Ask your BWH distributor or write us direct.**

**It will pay you also to get the facts on BWH Rotocured Transmission Belts which permit operation at lower tensions.

*Overcured Sections — present every 30' to 40' in all belts made by the flat press method. Only Rotocuring (continuous, non-stop curing) eliminates this major cause of belt failure.

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Distributors in all Principal Cities

PLANT: CAMBRIDGE, MASS. • P.O. BOX 1071, BOSTON 3, MASS., U.S.A.
WAREHOUSE STOCK: 111 NORTH CANAL ST., CHICAGO, ILLINOIS

BWH — DEPENDABLE RUGGEDNESS

We claim to be best equipped
to supply your most exacting requirements in

DIE CASTINGS

"LET'S LOOK AT THE RECORD"

(With due respect to the late Governor Al Smith)

. . . We have seven modern plants strategically located, designed and organized by men of 50 years' experience in the die casting field.

. . . We are the World's largest Producer and Finisher of die castings.

. . . We have a record of NO labor disputes during the life of our Company and its predecessors.

. . . We cast every die-castable non-ferrous alloy used commercially.

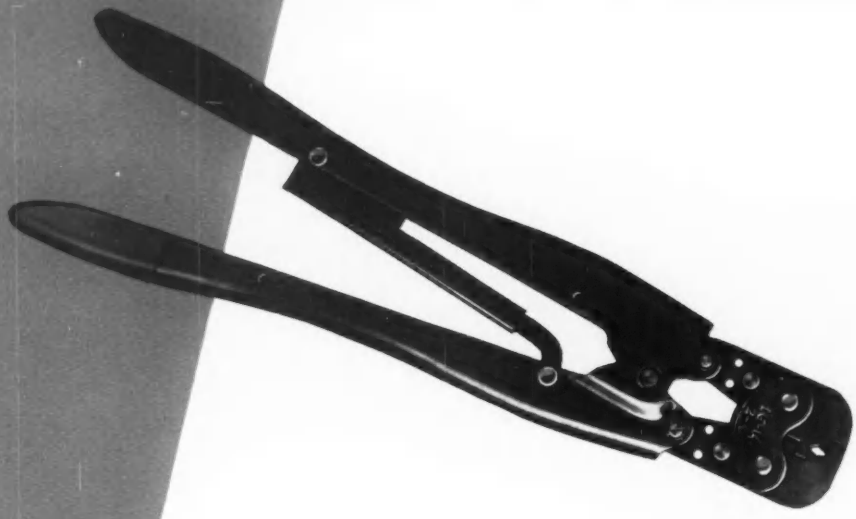
. . . We have received the highest citations from our Government, Army and Navy in World War I and World War II.

DOEHLER-JARVIS CORPORATION

The World's Largest Producer and Finisher of Die Castings

PLANTS AT TOLEDO, OHIO · POTTSTOWN, PA. · GRAND RAPIDS, MICH. · BATAVIA, N. Y. · CHICAGO, ILL.

EXECUTIVE OFFICE: 386 FOURTH AVENUE, NEW YORK, N. Y.



know them by their colors

Dot and color code devices are but two of the many advantages offered by AMP wire termination methods. Each PRE-INSULATED DIAMOND GRIP* terminal is identified by a bright color for each wire size range. Tools are color-matched accordingly, and, in addition, leave a small "brand" or dot code which positively identifies the use of the correct crimping tool.

AMP terminals and AMP hand, pneumatic, or automatic tools are playing vital roles in defense effort by making it possible to produce the highest quality wire terminations at low cost in minimum time!

*Trade-Mark
AMP Trade-Mark Reg. U.S. Pat. Off.

In Canada: ONTARIO, R. M. HUTCHESON, 10 Nordale Crescent, Hardington, P. O. Toronto 15, Elgin 5647

QUEBEC, BRUCE C. WALLACE, 3275 Linton Boulevard, Apt. 9 Montreal, Belair 8345

AMP

AIRCRAFT-MARINE PRODUCTS INC.
2100 PAXTON STREET, HARRISBURG 1, PA.

Let's talk turkey about tubing ...double-walled Bundyweld!

Bundyweld Tubing is double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

No other small-diameter tubing offers all the features of famous Bundyweld. For no other tubing is like it.

This multiple-walled type of Bundy® tubing is double-rolled from a single strip of steel, and copper-bonded throughout 360° of wall contact. Bundyweld is extra-sturdy, easy to fabricate, highly resistant to vibration fatigue or stress in rugged, gruelling spots.

Behind the Bundyweld features are superlative skills and services that only the world's largest producer of small-diameter tubing can provide in the design and fabrication of tubing parts. Why not call Bundy Tubing Company today?

Bundy Tubing Company

DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN ENGLAND, FRANCE AND GERMANY

Reprints from this or other Logbook pages are available for your files. Request them from our Redwood City, California office

Seals safeguard pressure lube system in air compressor crankshaft

Gardner-Denver Model WB Air Compressors employ a simple and practical pressure system to lubricate the crankshaft bearings. Oil seals are used to safeguard bearings and insure efficient operation of the pressure system.

In these compressors, lubricating oil is introduced under pressures ranging from 20 to 45 pounds. Operating temperatures reach 130°F, and shaft speeds of 870 rpm are maintained continuously.

The lubricant is introduced at the forward main bearing (Figure 1). It passes from the end plate through a brass oil-introducing ring, and on to a rifle-drilled crankshaft. The oil-introducing ring is kept from turning by a snap ring, and is hydraulically balanced in position by oil around the crankshaft.

National Oil Seals installed in the end plate prevent leakage or loss of lubricant, help maintain lube pressure and the balance of the oil-introducing ring.

Oil seals used in this application are National 50,000 series spring-loaded units (Figure 3). Sealing members are of Nationalized leather, impregnated to retain shape and resist wear. Here, as elsewhere in Gardner-Denver units, standard design seals are used. In many cases, standard designs can solve sealing problems quickly and economically. In other cases, special designs are necessary. Whatever the need, National Oil Seal Engineers bring 25 years of sealing experience to your problem. Write or call the nearest National office for prompt assistance.

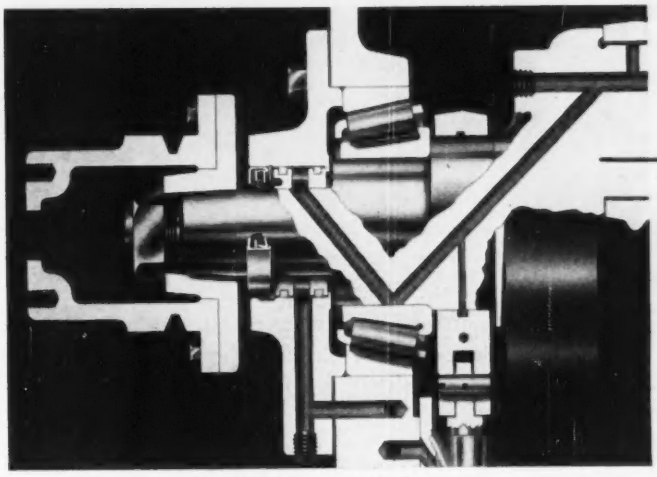


Fig. 1 Oil introducing assembly

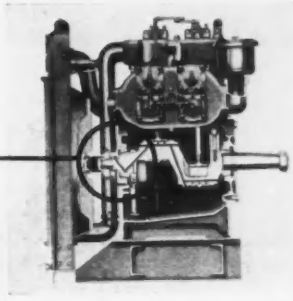


Fig. 2
Gardner-Denver Model WB Air Compressor

Fig. 3 National 50,000 series oil seal

"Let Your Decision be Based on Precision"

NATIONAL OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2282

CALL IN A NATIONAL FIELD ENGINEER

BUFFALO, N. Y. . . . . *Room 1124, Prudential Bldg., Mohawk 9222*
CHICAGO, ILL. . . . . *Room 2014 Field Building, Central 6-8663*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., Yellowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, Justin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, Trinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., Topaz 2-8166*
WICHITA, KANSAS . . . . . *519 South Broadway, Wichita 2-6971*
MILWAUKEE, WIS. . . *647 West Virginia Street, Broadway 1-3234*
NEW YORK CITY, N. Y. . . *122 East 42nd Street, Lexington 2-8260*
PHILADELPHIA, PA. . . *401 North Broad Street, Bell-Walnut 2-6997*
REDWOOD CITY, CALIF. . . *Broadway and National, Emerson 6-3861*
WEST SPRINGFIELD, MASS. . . *1025 Elm Street, Springfield 2-1881*
SYRACUSE, N. Y. . . . . *P.O. Box 1224, Baldwinsville 662*

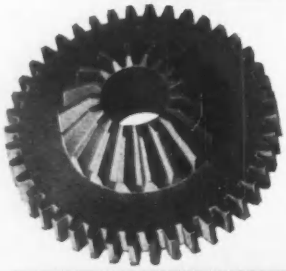
In Powder Metal they cost 80% less!

Products of Powdered Metal Products Corporation of America, Franklin Park, Illinois, specialists in gear making.

Bevel gear for power drill

Each of these gears is prohibitively expensive to make by conventional machining operations. In powder metal, each is formed at a single stroke.

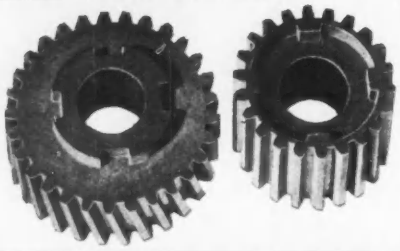
The small bevel gear for a power drill has a tensile strength of 100,000 psi. Savings in powder metal: 8 machine operations, 86% of total cost.



The mitre gear is used in a business machine. Savings in powder metal: 15 machining and assembly operations, 80% of total cost.

Spur and mitre gear for business machine

The helical and spur gear are used in an automatic washing machine transmission. Savings in powder metal: 18 machining and assembly operations, 88% of total cost.



Helical and spur gears for transmission in washing machine

To these and many other parts difficult or costly to form, powder metal processing is rapidly extending its many economies. Consult Stokes, makers of powder metal presses, on powder metal possibilities. Send parts or blueprints for report by Stokes engineers on their adaptability to powder metal processing.

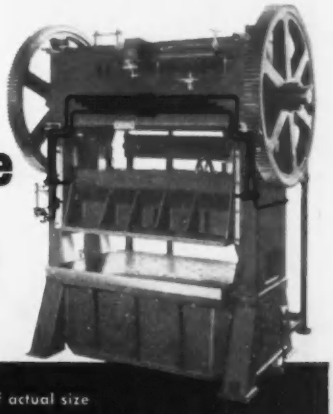
A comprehensive booklet "Powder Metallurgy Today" will be sent on request.

STOKES

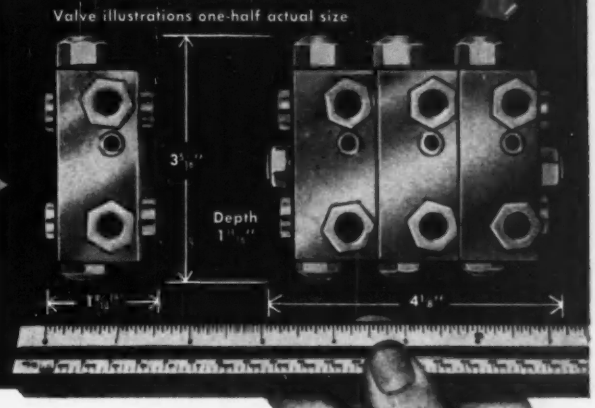
STOKES MAKES
Plastics Molding Presses,
Industrial Tabletting
and Powder Metal Presses,
Pharmaceutical Equipment,
Vacuum Processing Equipment,
High Vacuum Pumps and Gages,
Special Machinery

F. J. STOKES MACHINE COMPANY, 5900 TABOR ROAD, PHILADELPHIA 20, PA.

To help you... design more production time into the heaviest machines



ALEMITE TYPE II Accumeter VALVES



Specially designed for tough-job lubrication . . . to enable you to *design* in greater production output on the largest, heaviest machines! Alemite's Type II Accumeter System extends the protection of automatic *mechanized* lubrication to mines, steel mills, processing plants everywhere. Gives you a *fully enclosed* system that can be used indoors or outdoors, can be painted or treated with anti-corrosives, and will handle every type of oil or grease that can be pumped—from fluid oils to heavy non-fibrous greases.

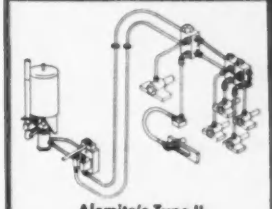
The Alemite Type II Accumeter Automatic Lubrication System consists of a lubricant pump, a distribution system of tubing, and *force-feed* valves mounted on or near individual bearings.

Automatically, from one central point, it safely, surely lubricates all the bearings on a machine—while production continues. Increases output by eliminating shut down for lubrication! Ends the risk of lubrication errors or neglect by your clients. Adds years to the life of the machine!

Unlike other systems, the valves on the Alemite Type II can be quickly serviced *without breaking the lines.* The valves have only three movable parts. Easily adjusted —adjusting pin cannot be knocked off. Nor is there ever the danger of scoring lap-fit metal.

No other method has equaled Alemite's Accumeter Systems for sustained accuracy in metering oil or grease to bearings. Tests show *no variation* in the amount of lubricant discharged to bearings . . . even after 73,312 lubrication cycles, equal to 122 years of twice-a-day service! Moreover, Alemite Accumeter Automatic Lubrication is not just "one-shot" lubrication. It is *continuous* between cycles. That's because Alemite's exclusive "accumulating" feature *prolongs* the discharge of lubricant to bearings.

To meet your full range of requirements, there are three different Alemite Accumeter Automatic Lubrication systems. Versatile in application, they are adaptable to machines of every type and size. Write now for Form 22-189, a free 16 page brochure giving full data. And for specific application recommendations, include description of machines you are now working on. Alemite, Dept. T-121, 1850 Diversey Parkway, Chicago 14, Illinois.



Alemite's Type II Accumeter System

Meters oil or grease to rotary, oscillating, stationary—plain or anti-friction bearings. Furnished in 4 capacities from .050 to .500 cu. in. All are adjustable. Single valves as well as manifolds of 2, 3, 4, and 5 are available. System handles up to 600 bearings. Manual or automatic operation.

ALEMITE

A PRODUCT OF SW STEWART WARNER

ACCUMETER AUTOMATIC LUBRICATION
1850 Diversey Parkway, Chicago 14, Illinois

Here's what we're doing

about the steel wire situation:

FIRST, of course, we're pushing production to the very limit.

Second, we're working with you, the user, to help you get the most out of the wire you're getting. Here's what we mean:

If you're having steel wire trouble, turn your problem over to our metallurgists. They've tangled with just about every problem in the history of wire fabrication. A problem that is totally new to you, may be a simple matter of recorded history for us.

For example: You may be using a wire that's unsuitable for the job it has to do. Perhaps a different grade can be used that will give the desired performance. Maybe your fabricating techniques can be improved, resulting in more uniform physical properties and less scrap.

You may be able to improve your product and actually cut your costs at the same time. We've seen that happen plenty of times.

In any event, if you have a wire problem, we'll be glad to give you all the help we can. We've always offered this service, but we think it's particularly valuable now.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High-quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire*

AMERICAN
MANUFACTURERS WIRE

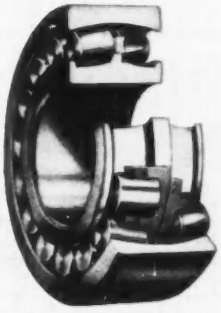
USS

UNITED STATES STEEL

"Caterpillar" Diesel Tractors develop

more workpower from horsepower

. . . through Torrington Bearings



In the constant mesh transmissions of "Caterpillar" D6, D7 and D8 Tractors, Torrington Spherical Roller Bearings are used to provide larger load capacity and smoother flow of power from the engine to the tracks.

On the upper transmission shafts of the D6, D7 and D8, and on the pinion shaft of the D8, these self-aligning bearings automatically compensate for possible shaft deflections—binding stresses cannot develop.

Torrington Spherical Roller Bearings are helping all kinds of heavy-duty equipment do a better job, with a minimum of "time-out" for maintenance. Why not let our engineers show you how these high-capacity bearings can improve the efficiency of your machinery?

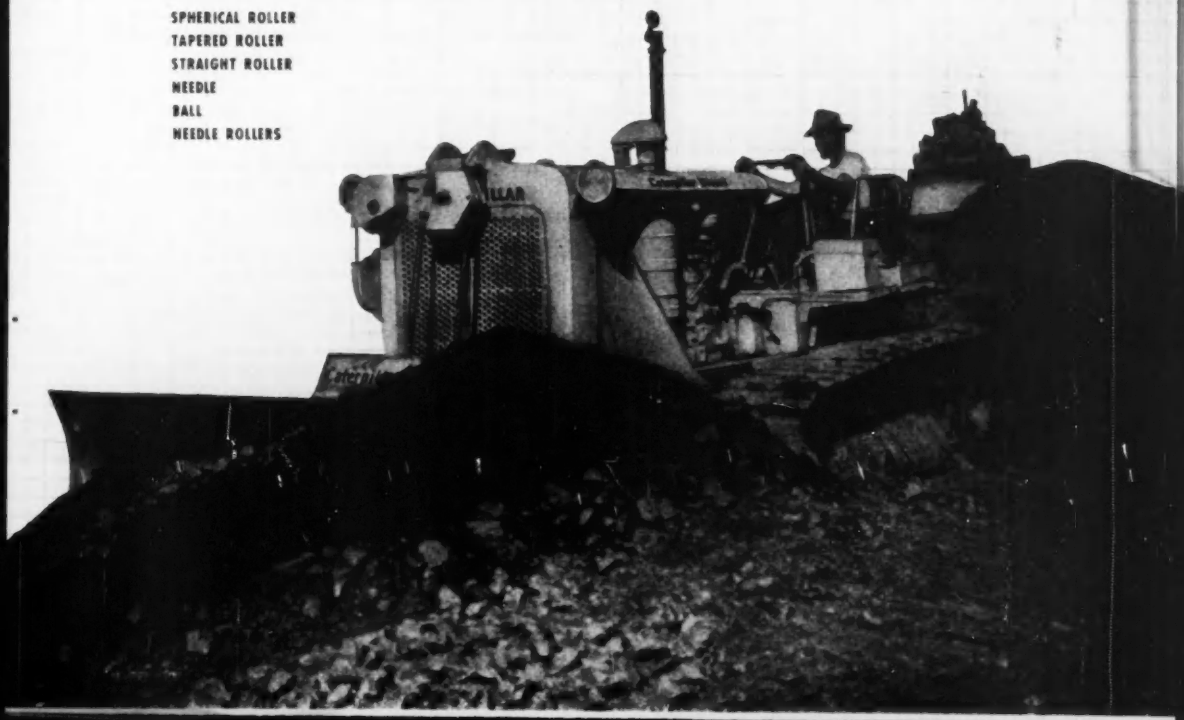
THE TORRINGTON COMPANY

South Bend 21, Ind. · Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON SPHERICAL ROLLER BEARINGS

SPHERICAL ROLLER
TAPERED ROLLER
STRAIGHT ROLLER
NEEDLE
BALL
NEEDLE ROLLERS



This 4" auger originally was made as a weldment. By redesigning it to a steel casting, using steel of similar analysis, the cost was reduced 40%.

As can be seen in the photographs above, the appearance was greatly improved — an advantage of steel castings which is particularly important when eye appeal of the product is a sales factor.

Evidence of the manufacturer's satisfaction is the fact that his 6" and 8" augers also have been converted to steel castings.

* * *

Here is another example of the engineering teamwork in design and redesign of parts which is resulting in greater serviceability and lower costs with steel castings.

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by the Steel Founders' Society of America.

An Urgent Message About *Scrap*...

There is a serious shortage of iron and steel scrap. Your company can help insure the continued high production of all metal products by getting your scrap into the hands of your scrap dealer. Will you do what you can to help...now?

STEEL FOUNDERS' SOCIETY OF AMERICA
920 Midland Building Cleveland 15, Ohio

Design and Build With Steel Castings

How to help a spindle carrier deliver precision

WITH six work spindles in its spindle carrier, the Greenlee automatic screw machine, shown below, can perform six cutting operations simultaneously. To maintain precision in each operation, all work spindles are mounted on Timken® tapered roller bearings.

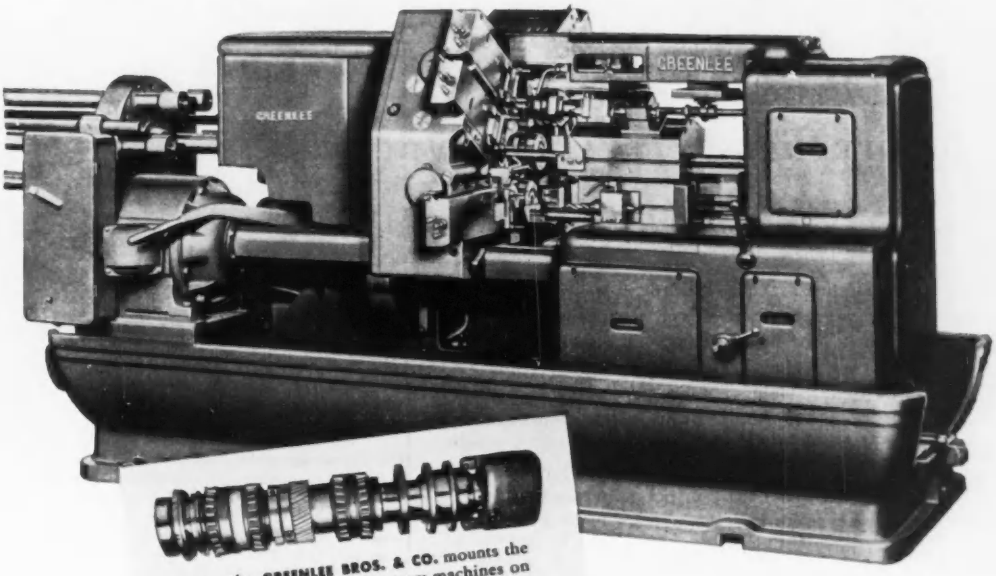
Timken bearings help eliminate spindle chatter. Work turns smoothly and accurately. Set-ups stay set. Greenlee Bros. & Co. also use Timken bearings in the gear box to provide a smooth flow of power through a wide range of speeds and feeds.

Because of tapered construction, Timken bearings take both radial and thrust loads in any combination, hold spindles in proper alignment. Line contact between rollers and races provides extra load-carrying capacity. The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction.

Since Timken bearings are engineered for the job, precision manufactured and made of special analysis Timken fine alloy steels, they normally last the life of the machine.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Make sure you have them in every machine tool you build or buy. Look for the trademark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How the **GREENLEE BROS. & CO.** mounts the spindles of its automatic screw machines on Timken bearings to insure lasting precision.

FINISHED TO CLOSER TOLERANCES

Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL — NOT JUST A ROLLER — THE TIMKEN TAPERED ROLLER — BEARING TAKES RADIAL — AND THRUST — LOADS OR ANY COMBINATION

Extra Savings in Design and Production...with *Mallory High-Density Alloy!*

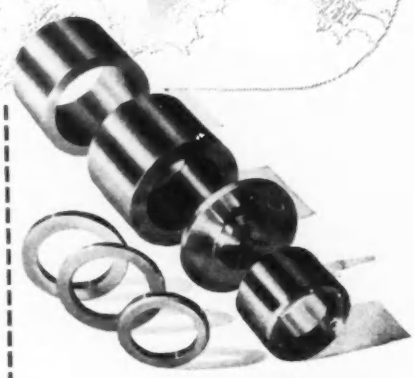
The list grows every day! Mallory non-ferrous alloys and ingenious applications are making big savings for more and more Mallory customers.

Here's an interesting example. Recently, a well-known manufacturer of aircraft instruments was faced with the necessity of increasing the stability of a gyroscope, in order to use it for larger planes. Plans included enlargement of the steel rotor . . . involved expensive re-tooling for the larger assembly. Mallory suggested that the rotor be made from readily-machinable, high-density Mallory 1000 Metal. Tests proved it to be ideal. The required stability was obtained with no increase in the size of the rotor or the gyroscope. Further . . . production delays and the expense of major re-designing were avoided.

That's service beyond the sale!

And whether your problem is metallurgical or electronic, what Mallory has done for others can be done for you!

In Canada, made and sold by Johnson Matthey & Mallory, Ltd., 110 Industry St., Toronto 15, Ontario



Mallory 1000

Mallory 1000 is a high-density metal whose density approaches that of pure tungsten, platinum and gold. It has great strength and is readily machinable. Its resistance to the corrosive action of many acids, as well as the atmosphere, is superior.

Mallory 1000 is ideal for uses where maximum weight in minimum space is required, such as gyroscope rotors, balance weights on crankshafts, variable-pitch propellers and centrifugal clutches. Its great density also makes it useful for shielding X-ray and gamma radiation.

As a leading producer of unusual alloys and materials from copper, silver, platinum, palladium, tungsten, molybdenum, aluminum-bronze, and nickel, Mallory is in a qualified position to make effective and impartial recommendations for materials best suited to your needs. Write today.

Metallurgical Products and Alloys

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

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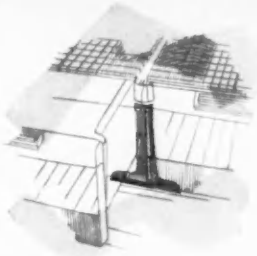
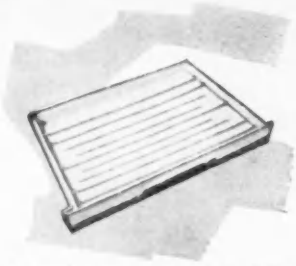
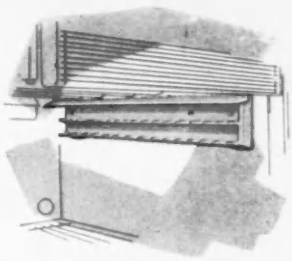
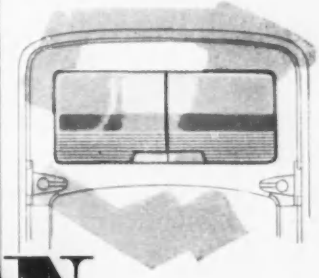






NOW AVAILABLE

STYRON 475



Admiral refrigerator parts shown are economically produced from Styron 475.

High impact formulation that answers the immediate need of Industrial Designers

Other Admiral Refrigerator Parts Are Made from 666, Another Formulation of Styron

Formulation 666 was used in making the following parts: upper inner door panel; hydrator pans; hydrator shelf; refrigerator tray; dairy drawer; freezer tray; name plates, knobs, etc.

Today Styron 475 is used by Admiral and other refrigerator manufacturers as a material outperforming all others in certain capacities. This was also true even when other engineering materials were in plentiful supply. Styron 475 is chosen by this great appliance corporation for its shock resistance, light weight, dimensional stability, resistance to moisture, moldability and design freedom.

Whether *you* are designing intricate functional parts or decorative products, versatile Styron 475 may be the material that points the way to improved production at lower cost. Investigate how Dow's strict quality control, consistent and uniform coloring and excellent technical services can help you produce component parts or complete products cheaper, better and faster.

Styron brand plastics, remember, are available in a wide range of *quality-controlled* colors and formulations, of which Styron 475 is one. Dow's Plastics Technical Service is equipped to help you determine the applicability of Styron to your manufacturing operation.

THE DOW CHEMICAL COMPANY

Plastics Department—PL-88

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The Styron label is the hallmark of quality in plastics goods.

STYRON *brand plastics*

. . . basic raw materials serving basic industries

DOW Plastics

THERMALLOY "30"

A cast heat-resistant alloy with high aged ductility

For service in the 1200°-1600° F. range

WRITE FOR NEW FREE FOLDER

Thermalloy* "30"—a 21% Cr 9% Ni alloy—has outstanding aged ductility characteristics and hot strength equal to that of 25% Cr 12% Ni type alloys. Since its alloy content is lower, Thermalloy "30" is also somewhat more economical.

In tests involving over 100 heats, excellent data has been obtained on stress rupture properties, aged ductility, oxidation resistance and mechanical properties. For additional information write for Bulletin T-211. Electro-Alloys Division, 2126 Taylor St., Elyria, Ohio.

THERMALLOY "30" OFFERS:

Improved Ductility— 18% minimum after aging for 24 hours at 1400° F.

Uniform Strength Levels— equivalent to and more uniform than 25% Cr 12% Ni types.

Greater Economy— since quantity of alloying elements is less than in similar types.

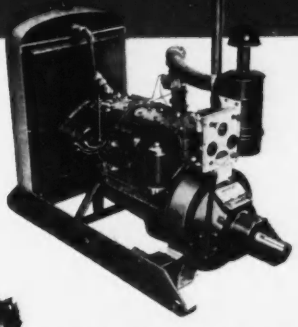
*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

ELYRIA, OHIO

You Profit from FORD POWER in 3 Big Ways!



This Tropic Breeze Wind Machine, made by National Frost Protection Co., Inc., is powered by either two Ford "254" six-cylinder or two "337" eight-cylinder Industrial Engines, depending upon the acreage to be protected.

A BROAD RANGE OF MODELS TO FIT EVERY INDUSTRIAL NEED

• By specifying Ford Industrial Engines and Power Units for your equipment, you can convert power into dollar-and-cents profit in these three important ways:

RIGHT POWER—A choice of five engines in many different models, built for industrial uses, ranging from 120 cu. in. to 337 cu. in. displacement, offer the *right* power with steady, efficient and economical performance for literally hundreds of applications.

RIGHT FEATURES—Each model has all the latest advancements of Ford's famed progressive engineering. A complete line of special Ford equipment, mobile components and accessories is also available to function economically under any operating conditions.

RIGHT SERVICE—No need to carry large inventory for replacements because your nearest Ford Dealer stocks them. This assures efficient, accessible service, too, at all times.

SOME TYPICAL FORD-POWERED DEFENSE APPLICATIONS ARE:

Compressors . . . Pumps . . . Welders . . . Cranes . . . Earth Augers . . . Stone Crushers . . . Generator Sets and many others

Ford

INDUSTRIAL ENGINES AND POWER UNITS

YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED

Our experienced Sales Engineers are at your service in developing engineering recommendations for the most efficient use of Ford Industrial Power in your application.

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I am interested in Industrial Power for:

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(state your application)

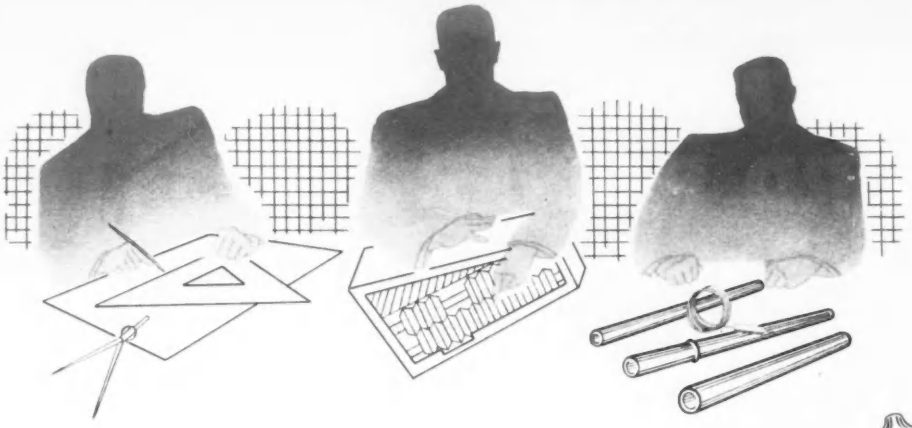
Send me latest literature on Ford Industrial Power (cu. in. dipl. and cylinders as shown.)
☐ "120" 4-Cyl. ☐ "226" 6-Cyl. ☐ "239" V-8 ☐ "254" 6-Cyl. ☐ "337" V-8

Firm Name _____
(Please print)

Attention of _____

Street _____

City _____ *Zone* _____ *State* _____ S



DESIGNING New Products ? IMPROVING an Existing One ? TUBULAR Parts Used ?

Our Customers Engineering Service can lend a helping hand and provide as much assistance as you want: help develop the design; suggest suitable materials; provide the necessary plain tubing or fabricate it into a special form; carry the development on through pilot tests or help produce the finished product.

Since we are accustomed to working with various government agencies, you can be assured that any developments carried on with you will likewise be kept on confidential basis.

Our tube fabrication facilities embrace such operations as bending, spinning, swaging, piercing, threading, counterboring, tapping, and beading. Seeing that the product reaches you in a usable condition is also of deep concern to us. We provide the most practical type of packing—crating, boxing, packaging, palletizing, etc.

With a background of over 34 years' specialized experience in tube manufacturing, we offer you help that should prove valuable in the production of any tubular part you contemplate. We invite your inquiries.

WOLVERINE TUBE DIVISION
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Manufacturers of seamless, nonferrous tubing
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the drive that has everything

compactness

large load capacity

low original cost

low operating cost

delivery out of stock

modern design

high quality precision gearing

Foote Bros. Line-O-Power Enclosed Gear Drives offer industry compact, straight-line units with efficiencies of 96% or higher.

Duti-Rated high hardness precision gears are assembled into streamlined housings of rugged cast iron.

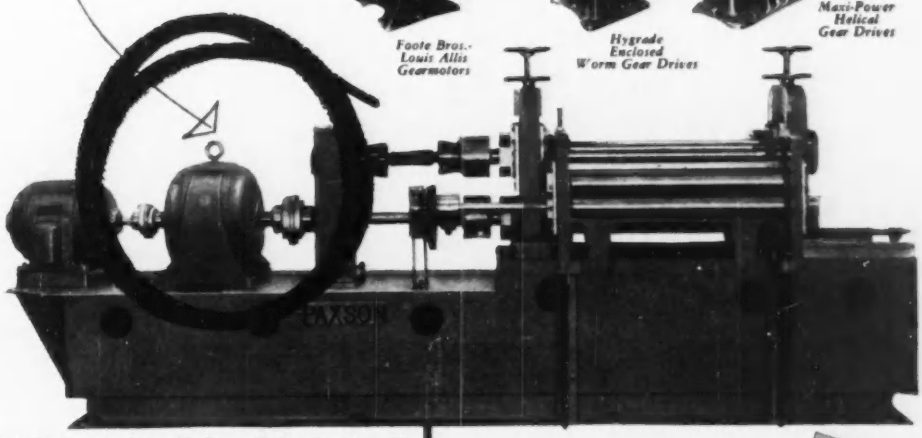
Economical in original cost because the latest, most accurate high production machine tools assure rapid production with exceptional accuracy for long wear life. Economical to operate because simplified construction, minimum number of moving parts, direct splash lubrication, quality workmanship all hold maintenance to a minimum.

Line-O-Power Drives are available for delivery from stock in double or triple reductions for capacities from 1 to 200 h.p., with ratios from 5 to 1 up to 238 to 1

Foote Bros.-Louis Allis Gearmotors

Hygrade Enclosed Worm Gear Drives

Maxi-Power Helical Gear Drives



Standard 36-inch slitter, manufactured by Paxson Machine Co., Salem, Ohio

FOOTE BROS.

Better Power Transmission Through Better Gears

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Chicago 9, Illinois

Please send me a copy of Bulletin LPB on Foote Bros. Line-O-Power Drives.

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Position .....

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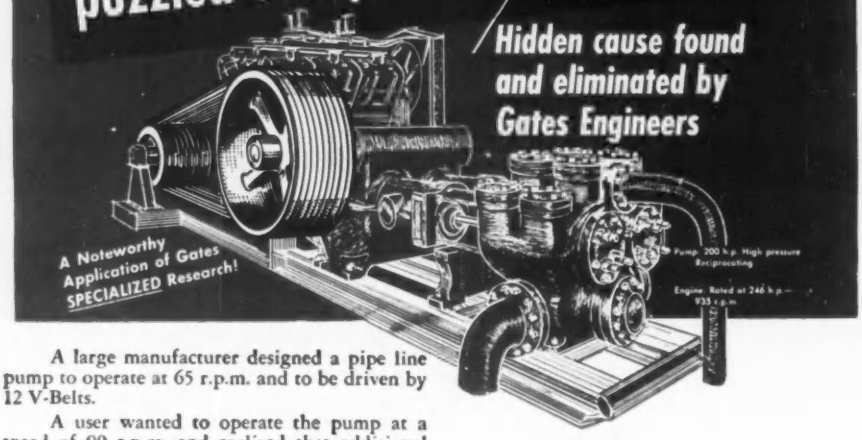
City ..... Zone ..... State .....

Severe vibration on pump drive puzzled everyone . . .

Hidden cause found and eliminated by Gates Engineers


A Noteworthy Application of Gates SPECIALIZED Research!
Pump: 200 h.p. High pressure Reciprocating
Engine: Rated at 246 h.p. — 935 r.p.m.

A large manufacturer designed a pipe line pump to operate at 65 r.p.m. and to be driven by 12 V-Belts.

A user wanted to operate the pump at a speed of 90 r.p.m. and realized that additional horsepower would be required. Upon checking the V-Belt drive, it was found that the additional belts required would increase the face width of the sheave and therefore the moment arm of the bearing load. Any increase in bearing load combined with the increased speed was distinctly undesirable and therefore the user sought some means of reducing the overhung weight and width of the sheave.

Learning that a *special* V-Belt had a sufficiently higher horsepower rating to gain the greater pump speed with *only 9 belts,* he had the drive re-designed to use these belts.

When installed on the job, the belts vibrated severely. At a speed somewhat below the desired range, the belts would fly completely off the sheaves. Operation was so rough that it was almost impossible to run the pump at all.

Gates Engineers were called in for consultation. Their analysis indicated that the particular belts used formed a *too-compliant* link between the pump and the engine. This allowed tortional vibration to build up to excess. Therefore, belts of *less compliance* would have to be used.

Accordingly, Gates Engineers wrote specifications for belts having the necessary h.p. rating but with the exact *degree of compliance* that would avert the vibration. These special V-Belts were built by Gates—installed—and the drive operates smoothly under all loads and at all speeds within the range.

The excessive vibration is gone. The clutch operates smoothly at any speed. And 13 additional pumps have since been equipped with identical belts—all operating most satisfactorily.

Gates ability to analyze and correct obscure drive difficulties is no accident—for Gates operates the largest V-Belt Testing Laboratories in the world. And Laboratory findings are carefully checked by tests made under actual field conditions. Finally, the *results* of these exhaustive tests are immediately reduced to *usable data* for the design of V-Belt drives to *perform whatever task may be required.*

Phone for a Gates Field Engineer

Only under exceptional circumstances, of course, will you ever need belts of special construction. But, more often, some drive in your plant may not be operating quite as it should. Or you may have a particularly difficult drive to design. Again, you may want to be sure what size and construction of V-Belts will give the most efficient and the lowest cost service on a certain drive. In any case, you have only to phone a Gates Field Engineer, *always near you* in all industrial centers.

Just look in your phone book under "Gates Rubber." A Gates Field Engineer will come right to your plant and put at your service the full benefits of Gates V-Belt knowledge and experience *without the slightest obligation!*

ENG-518

Gates
Hose V-Belts
Molded Rubber Goods
for Industry

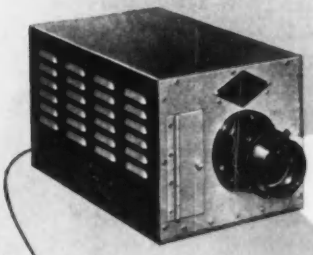
VULCO ROPE DRIVES
ENGINEERING OFFICES AND JOBBER STOCKS
IN ALL INDUSTRIAL CENTERS

THE GATES RUBBER COMPANY
The World's Largest Makers of V-Belts
DENVER, U. S. A.

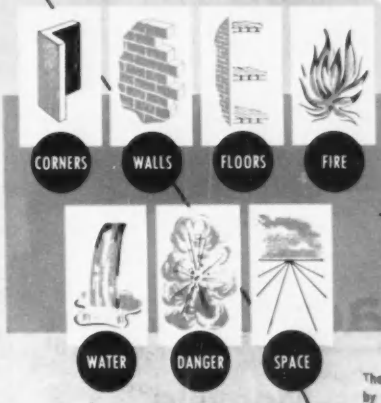
NOW You Can *See* Where You Can't *Look*

The DIAMOND "UTILISCOPE"

(WIRED TELEVISION)



CONTINUOUS OBSERVATION by "UTILISCOPE" CAMERA



These Are *NO LONGER* Obstacles to Seeing Exactly What Is Happening

The Diamond "Utiliscope" (television which transmits by wire instead of by broadcast) provides a clear, faithful, instantaneous reproduction at a distance of any operation, scene or demonstration. The image can be brought right to the control panel, or desk of the operator or supervisor. Obstacles that prevent direct observation (such as danger, distance, building members, etc.) are not obstacles to the "Utiliscope" which enables you to "SEE where you can't LOOK." There is no measurable time lag and the "Utiliscope" cannot give incorrect information.

The "Utiliscope" is surprisingly simple . . . has fewer tubes than a good radio. No special skill is required for installation and operation. Stability and reliability are exceptional . . . and the cost is very moderate.

The "Utiliscope" is now in continuous use (24 hours a day) saving labor, improving product quality, preventing accidents and increasing production. Let us tell you about some of these installations that may suggest solutions to your own problems . . . write for Bulletin 1025.

TYPICAL USES— Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces • Viewing nuclear research • Coordinating materials flow on conveyors.

The "Utiliscope" (Registered U. S. Patent Office)

4524

DIAMOND POWER SPECIALTY CORP.

FIRST IN INDUSTRIAL TELEVISION

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Diamond Specialty Limited — Windsor, Ontario

WRITE FOR BULLETIN 1025

Since 1903, Diamond has Manufactured Quality Equipment For Industry

This is An "EXPLORATORY" Advertisement

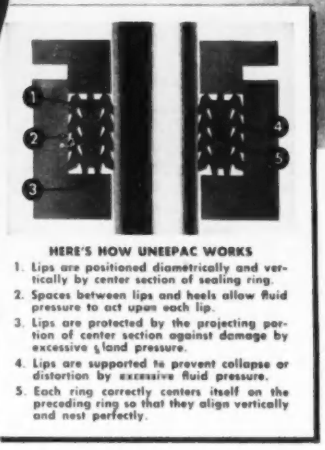
Frankly, we don't know what uses the design engineer may find for the "Utiliscope" (Wired Television) . . . so in adjacent ad we are simply telling you what it will do. Based on our experience in several fields, we suspect there are many places where the "Utiliscope" will help you improve product quality, save manpower, prevent accidents or increase production.

If you want to look into the possibilities of the "Utiliscope", simply write us for a copy of Bulletin 1025J which explains the equipment and shows various applications. Please address your request to Department "J".

DIAMOND POWER SPECIALTY CORPORATION

Department "J", Lancaster, Ohio

Seals in a MINIMUM of space...



HERE'S HOW UNEEPAC WORKS

1. Lips are positioned diametrically and vertically by center section of sealing ring.
2. Spaces between lips and heels allow fluid pressure to act upon each lip.
3. Lips are protected by the projecting portion of center section against damage by excessive gland pressure.
4. Lips are supported to prevent collapse or distortion by excessive fluid pressure.
5. Each ring correctly centers itself on the preceding ring so that they align vertically and nest perfectly.

Uneepac

...the new Johns-Manville automatic ring packing

EQUIPMENT DESIGNERS are finding that this newest Johns-Manville packing development enables them to hold stuffing-box sizes to a minimum . . . thereby save both space and machining.

This ability of Uneepac to provide high sealing efficiency in minimum packing depth results from the fact that each ring is a complete self-contained packing unit. Uneepac is designed so that the center section of each ring positions the lips and protects them from excessive gland pressure. Header and follower rings are therefore seldom required.

In addition, Uneepac offers other advantages that are important both to the designer and the user:

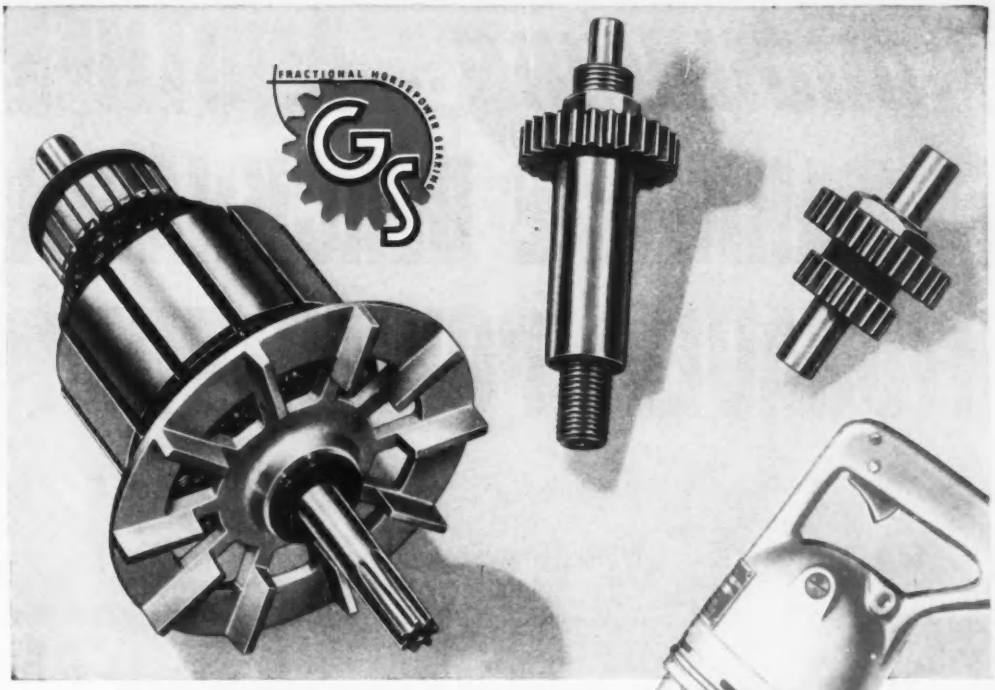
SIMPLIFIED INSTALLATION—Each Uneepac ring centers itself on the preceding ring so that the entire set is aligned vertically and nested perfectly. This feature practically insures trouble-free installation.

MORE EFFICIENT SEALING—Because it is designed so that each lip is always exposed to fluid pressure, Uneepac has excellent pressure sensitivity . . . is instantly responsive to fluid pressure changes.

REDUCED FRICTION AND WEAR—The operation of this new automatic packing is completely independent of gland pressure. This reduces friction to a minimum—saves wear on both rod and packing—and contributes to longer life with corresponding reductions in down time for replacements.

Uneepac is available in sizes from 5/8" inside diameter to 63" outside diameter. For complete information, write Johns-Manville, Box 290, N. Y. 16, N. Y.

Johns-Manville PACKINGS & GASKETS



SIGNAL'S Requirements Are *TOUGH!*

HARD-HANDED maintenance, construction and building workers invariably favor the OB-4 Standard Duty Drill by Signal Electric of Menominee. Its maker tells you . . "an abundance of power is built into this compact unit". . and, " it *assures dependable service*"! The secret of SIGNAL's success is their insistence upon only the finest components. For instance, their Fractional Horsepower Gearing is by G.S. Their specifications demand special alloy, heat treated steels and extreme mechanical precision. Quality must be *uniform* . . rejects are intolerable! Here again, G.S. *better* Gearing pays off in the kind of service and satisfaction that means so much to our customer's sales and profits.

Whether your production is civilian or defense, you too can benefit by using our superior skills and facilities. Decide now to delegate the responsibility for Small Gearing to the well trained G.S. staff. Will you call on us for service SOON?

SEND FOR . .

Free new 6-page folder illustrating and describing G.S. facilities, Small Gearing and applications, together with handy charts. Will you ask for it on company stationery, please?

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Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

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WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Announcing... ANOTHER REMARKABLE BLACKHAWK HYDRAULIC POWER PUMP

UP TO 93% over-all operating efficiencies!

QUIET . . . vibrationless!

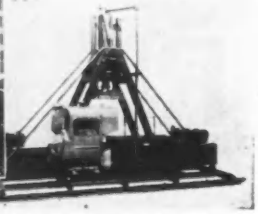
ADAPTABLE to an infinite variety of loads and speeds!

For the finest in modern power pumps, you'll want the new Blackhawk P-237. Here's a 6-piston, wobble plate design with a 15 hp maximum intermittent capacity.

As for economy — you pay no premium for the advantages offered by the P-237. Compactness and over-all efficiency spell important design savings for your equipment. And operating and maintenance costs go down.

Performance? For example, you can deliver 3 gpm at 1350 rpm and 6000 psi . . . *with only 11.65 hp input.* And long life at unsurpassed efficiencies is assured by husky anti-friction bearings. You'll want full facts on these and many other features.

A bank of three P-237 Blackhawk pumps make up the "hydraulic heart" of this famous Bucyrus-Erie "Hydro-Crane." Blackhawk valves give finger-tip control of boom, hoist line, clam-shell jaws and outriggers.



Two P-237 Pumps (along with Blackhawk control valves) are used on this 100-ton G. T. Bynum Co. oil field pipe straightener for pipe up to 16 in.

ALREADY SUCCESSFULLY APPLIED on rugged equipment of leading manufacturers

Following are typical installations of the P-237 Pump:

Cranes	Snow Plows
Bulldozers	Mining Machinery
Loaders	Hydraulic Presses
Trench Diggers	Materials Handling Equipment
Scrapers	Test Stands
Road Graders	Farm Implements
Dump Trucks	Tractors

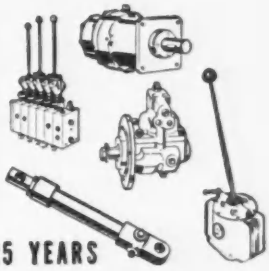
BLACKHAWK

MOBILIZATION NOTE:

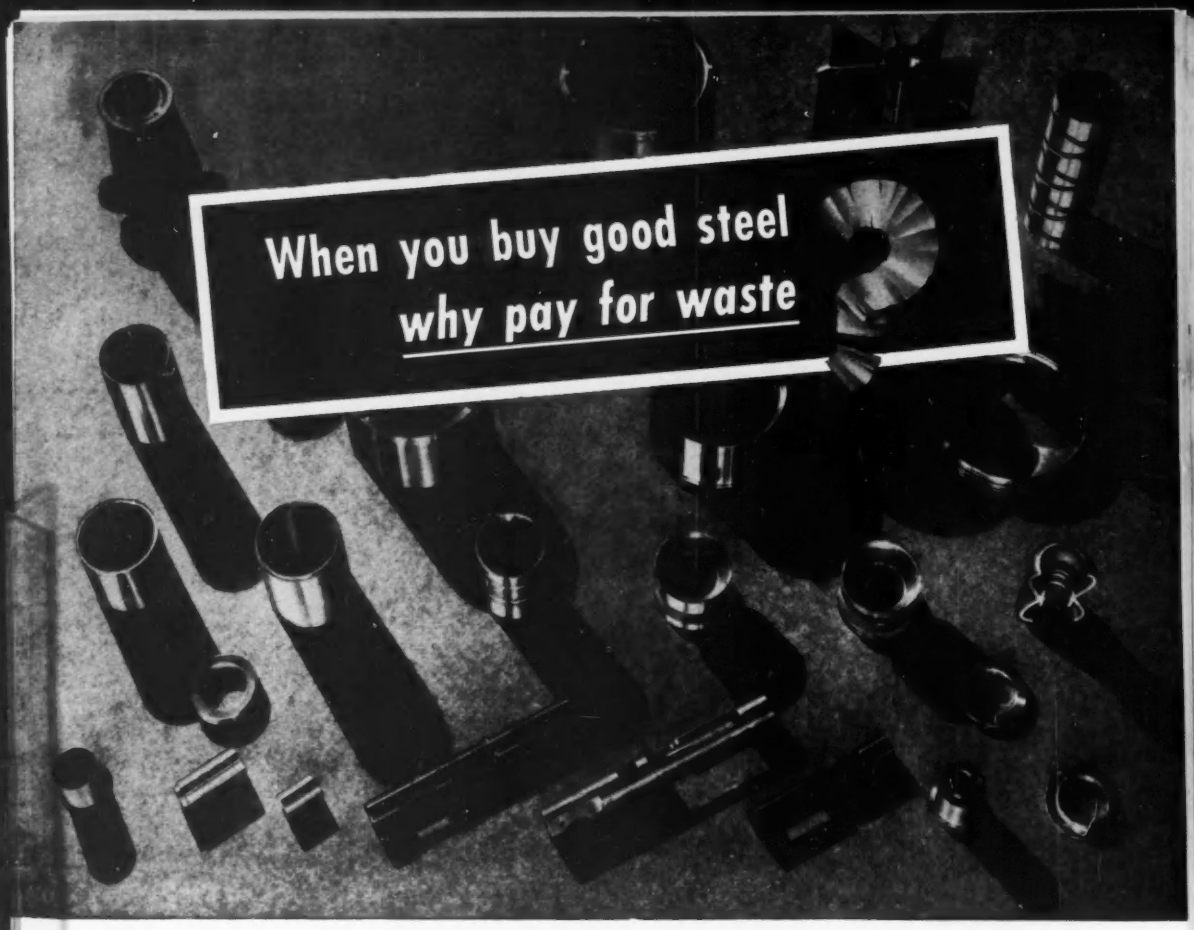
If you are producing or quoting on a DEFENSE PROJECT *requiring hydraulic components* — remember Blackhawk is a veteran in meeting government specifications . . . will fulfill complete responsibility for you — including cost analysis and engineering development if needed. This experience is at your service.

YOU ARE INVITED

to write for Bulletin 3-B on Blackhawk "Hydraulic Pumps, Rams and Valves" as well as for Bulletin 2-P on the new P-237 Power Pump. Blackhawk Mfg. Co., 5300 W. Rogers, Milwaukee 1, Wis.



PIONEER SPECIALISTS IN HIGH-PRESSURE HYDRAULICS FOR 25 YEARS



TIGHTENING the belt on production costs? Then be sure that you don't have too much of your good steel stock lying on the floor as scrap. It's wasteful, expensive and usually unnecessary.

You can save money, time and steel when you use SHELBY Seamless Steel Tubing for hollow cylindrical parts. With tubing, less cutting or boring is required than with solid bars . . . tools last longer. And, since *the basic shape is already made*, fewer operations are required. Rejects go down. Time is saved.

For some good examples of how other parts manufacturers have simplified their production cost problems, take a careful look at the products on this page. Despite the complexity of some, each of them was made from SHELBY Seamless Steel Tubing. In some cases, manufacturing costs are *50%* less than identical products machined from solid bar stock.

Our service engineers will be glad to help you utilize the many advantages of seamless steel tubing for *your* product. Get in touch with us today, draw upon the priceless experience of National Tube Company—world's largest manufacturer of tubular steel products.

FREE BOOKLET

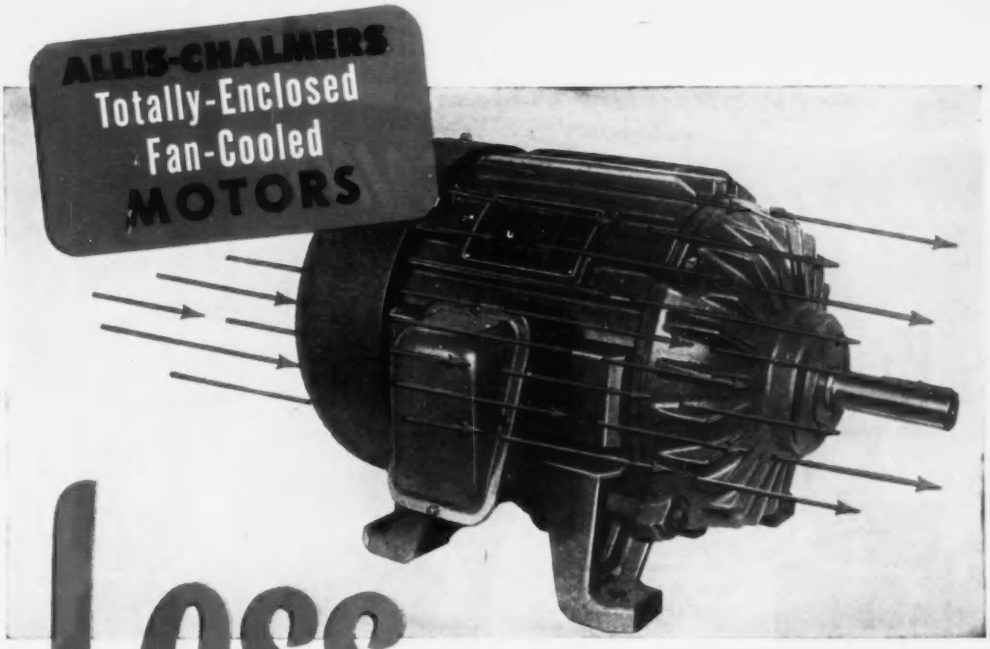
Tells you how to cut production time, production costs, and make better parts in the bargain. Write to National Tube Company, Frick Building, Pittsburgh 19, Pennsylvania.

NATIONAL TUBE COMPANY, PITTSBURGH, PA
(TUBING SPECIALTIES DIVISION)
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

Shelby Seamless Steel Tubing

UNITED STATES STEEL



Less MOTOR CLEANING ...INSPECTION...OVERHAUL!

HERE'S A MOTOR that actually blows itself clean! Dirt is carried away by cooling air blown over the ribbed cast iron frame and bearing housings of this new Allis-Chalmers tefc motor.

Dirt can't build up to cause overheating. Concealed air passages and pockets have been eliminated. Even oily dirt that sticks can simply be wiped or blown off.

And this means savings! Maintenance costs are traditionally low on totally-enclosed, fan-cooled motors. But they're lower than ever before on the new Allis-Chalmers Type APZ tefc motor.

Rigid Construction

The frame is cast iron which has high resistance against corrosion and distortion. Bearings are pre-lubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment.

Get All The Facts

The new Allis-Chalmers Type APZ totally-enclosed, fan-cooled motor is built in all NEMA standard frame sizes from 224* to 505. Also in explosion-proof type. Your A-C Authorized Distributor or District Office has complete information. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225.

A-3426

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ½ in. to 72 in. discharge and up.

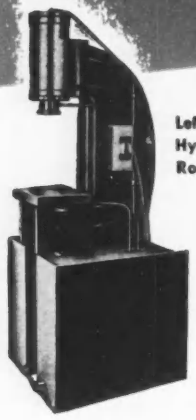
Texrope and Vari-Pitch are Allis-Chalmers trademarks.

ALLIS-CHALMERS

*Similar design non-ventilated motors Type APK, also available in frames 203 to 224 inclusive.

This MEEHANITE Ram Cylinder is...

"GUARANTEED AGAINST FAILURE"



Left—Ross & Company 20 Ton Hydraulic Press for Shop—Tool Room or Production Line

Right—The double acting Meehanite Ram Cylinder, honed to a mirror finish, is the heart of the hydraulic pump system.

Ross & Company, Chicago, Illinois, manufacturers of the 20-ton hydraulic press illustrated, fully guarantee their product "against failure due to workmanship or *material* for six months after date of sale." As an important component of this unit they specify only Meehanite cylinders which must be honed to a mirror finish. The versatility and accuracy of the action of the hydraulic pump is largely dependent upon the cylinder and its flawless, long wearing surface.

Only through rigid control of the metal structure can the needed engineering characteristics for a part of this type be obtained regularly and consistently. The Meehanite production processes provide these controls with the result that to designers, engineers and production executives throughout industry, Meehanite castings are synonymous with better properties, uniformity, dependability:—in a simple word QUALITY.

Write for our 25th Anniversary booklet "25 Years of Proof in Service."

25th Anniversary METAL 1926-1951

MEEHANITE

NEW ROCHELLE, N. Y.

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Blake Steel Co.	Mahwah, New Jersey
The American Foundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Benton Iron Works	St. Louis, Missouri
Bowen Foundry & Machine Co.	Irvington, New Jersey
C. W. Bray Co.	Hastings, West and Center Sts.
Builders Iron Foundry	Providence, Rhode Island
Chattanooga Foundry	Birmingham, Alabama
Columbia Steel Co.	Portland, Oregon
Crucible Steel Co. of America	Midland and Grove City, Pa.
The Crook Reservoir Co.	Mt. Vernon, Ohio
Danville Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Federal Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Hamilton Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hamilton Company, Inc.	New York, New York
Hilo Iron Manufacturing Co.	York, Pennsylvania
Hinchman Renshaw, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long, Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Pelton Pattern Co.	Bridgewater, Massachusetts
Pennsylvania Foundry Co., Inc.	Buffalo, New York
Pennsylvania Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross Meehan Foundries	Chattanooga, Tennessee
Shenango Penn Mold Co.	Dover, Ohio
Stanley A. Foundry Co.	Worcester, Massachusetts
The Stearns Foundry Manufacturing Co.	Denver, Colorado
Turner Engineering & Mfg. Co.	Allentown, Pennsylvania
Vulcan Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Western Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

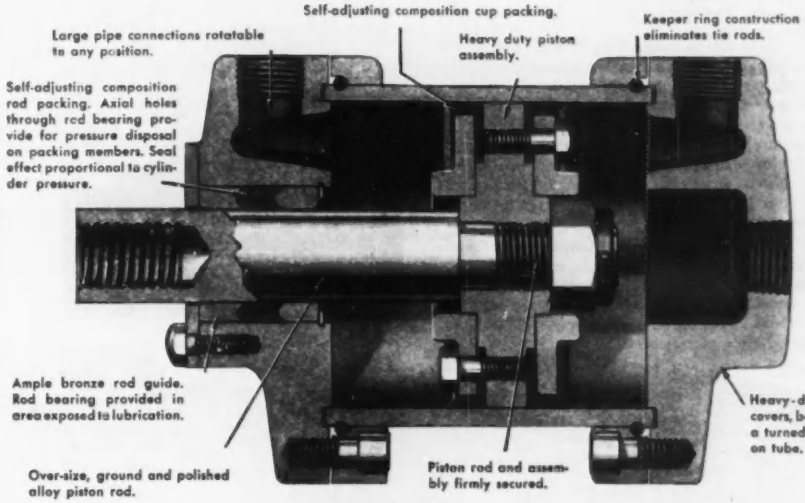
Avoid air power failure!

Choose Rivett Air Cylinders

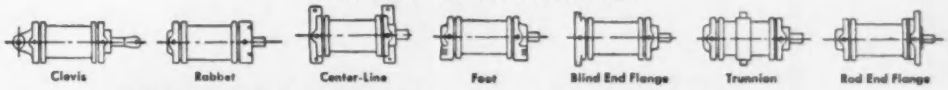
The importance of smooth, steady cylinder performance cannot be over-emphasized in today's production. Only too often a whole line is slowed down, or stopped altogether because of a faulty cylinder.

You can rely on Rivett air cylinders to provide dependable service. Study the construction features shown below. They represent many years of practical cylinder design — and are the basis on which thousands of satisfied customers have purchased Rivett.

Recommended for pressures up to 150 P.S.I., Rivett air cylinders are available in 7 standard mountings; in 9 bore diameters, in any length stroke up to 96", single or double-end rods, with internal or external thread, and cushioned rod end, blind end, or both. Special covers supplied. Send today for Catalog Section 55.


Self-adjusting composition cup packing.
Large pipe connections rotatable to any position.
Heavy duty piston assembly.
Keeper ring construction eliminates tie rods.
Self-adjusting composition rod packing. Axial holes through rod bearing provide for pressure disposal on packing members. Seal effect proportional to cylinder pressure.
Ample bronze rod guide. Rod bearing provided in area exposed to lubrication.
Heavy-duty alloy covers, bored to fit a turned diameter on tube.
Over-size, ground and polished alloy piston rod.
Piston rod and assembly firmly secured.

SEVEN STANDARD MOUNTINGS



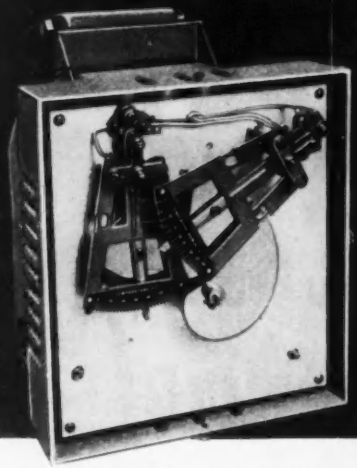
RIVETT LATHE & GRINDER, Inc. • Dept. PE-12 Brighton 35, Boston, Massachusetts

RIVETT furnishes a complete power package

VALVES • CYLINDERS • POWER UNITS

Air and Hydraulic
All sizes and types

DIE CASTING prevents "profit corrosion"



CASE HISTORIES FROM MT. VERNON FILES

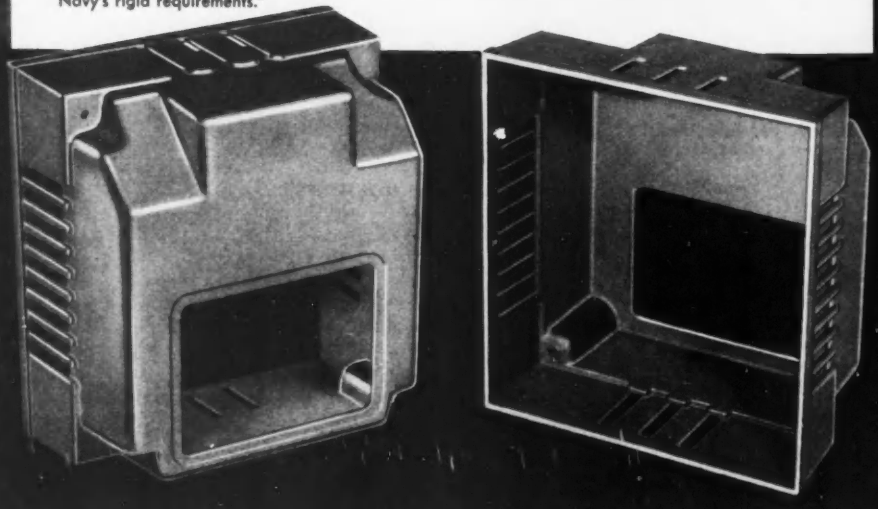
Nothing is so detrimental to profitable production as *waste of time and material.*

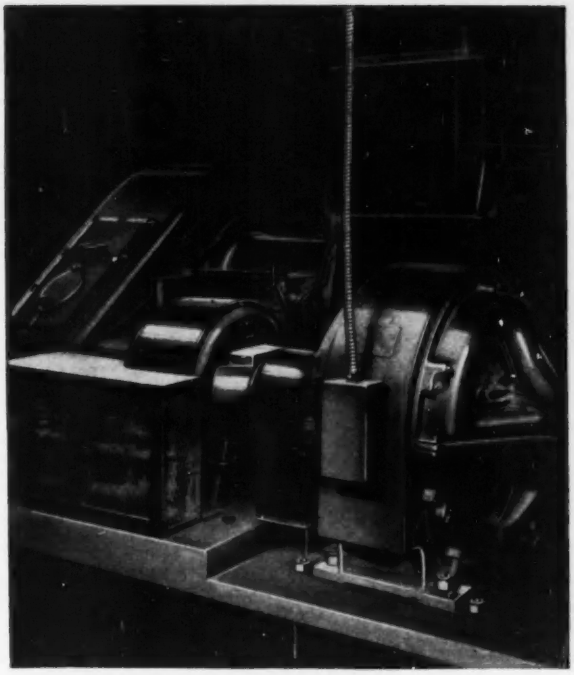
That's why you can benefit by giving serious thought to die casting, for die casting is industry's high-speed, cost-cutting method — promoting economy from start to finish on any production job.

Take for example, this temperature and humidity measuring instrument, used by the U. S. Navy to maintain non-corrosive atmospheric conditions aboard mothballed ships: Definite savings are realized by die casting the housing, because die casting produces this component *instantly*—and with maximum economy of metal. Not only are costs held down, but a superior product is obtained—strong, light, good looking, and adaptable to any type of finish.

Says The Instruments Corporation: "This Mount Vernon casting has proved itself to be the most satisfactory as well as the most economical housing that could be produced for the purpose. We consider it amply fulfills the Navy's rigid requirements."

Whenever *you* need a part or product made, therefore, don't forget die casting. Let us know your problems; send us your specifications. We've steered numerous manufacturers to high-output, low-cost production . . . shown them how to prevent *time waste* and *material waste* from eating into their profits.





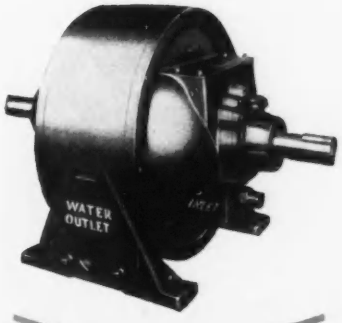
Model 8W Dynamatic Water-Cooled Coupling used to obtain adjustable speed from 200 HP, 720 RPM synchronous motor to drive a Plasticator carrying rubber from a Banbury Mixer in the plant of a large tire manufacturer.

DYNAMATIC®

WATER-COOLED POWER COUPLINGS

WIDE SPEED RANGE
INSTANTANEOUS RESPONSE
ACCURATE SPEED CONTROL
STEPLESS SPEED ADJUSTMENT
SMOOTH TORQUE TRANSMISSION
TOTALLY ENCLOSED
SIMPLE • QUIET
COMPACT • EFFICIENT

Provide Adjustable Speed Drive with any AC Motor



The Dynamatic Coupling transmits rotation from a driving to a driven member without mechanical contact—with stepless adjustable control and with almost instantaneous response. It is a simple and effective method of providing adjustable speed from a constant speed source (or vice versa) with full-torque starts. The addition of an eddy-current brake will provide smooth controlled deceleration.

Effective water-in-the-gap cooling makes possible large capacity in small space, and the construction provides complete protection of the interior of the coupling against atmospheric impurities.

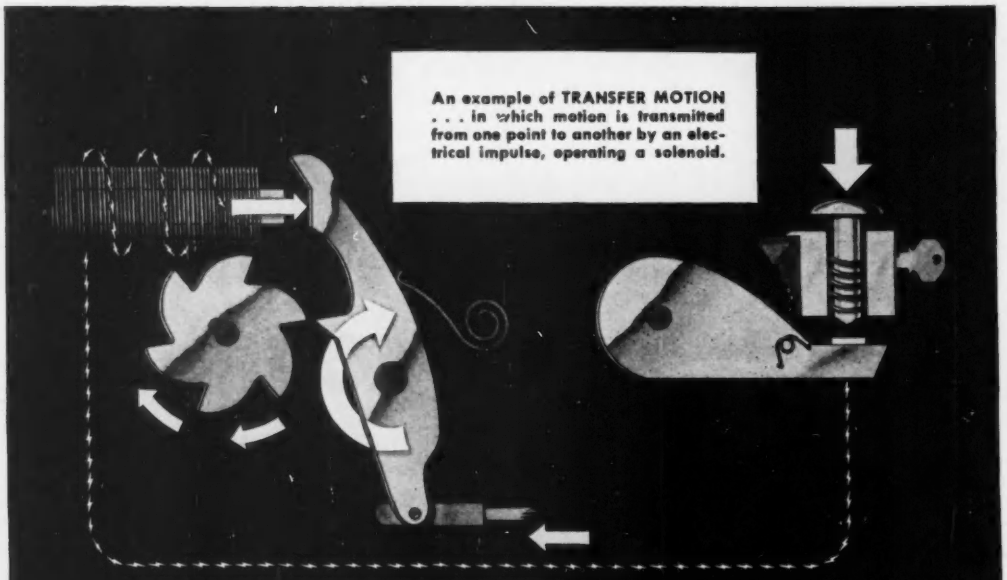
A standard range of sizes of Dynamatic Water-Cooled Couplings is available for transmitting torques of 50 pounds feet up to approximately 5,000 pounds feet. Many other sizes up to and including single units for handling 200,000 pounds feet of torque are in service and units of larger capacity can be built to order.

Write for Illustrated Bulletin WC-1

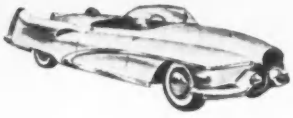
DYNAMATIC® CORPORATION • KENOSHA WISCONSIN

Subsidiary of EATON MANUFACTURING COMPANY, Cleveland, Ohio

Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls


An example of TRANSFER MOTION . . . in which motion is transmitted from one point to another by an electrical impulse, operating a solenoid.

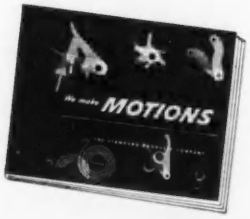
If it needs to behave like a latch, a lock, or a linkage...
we can create it...mass produce it...WITH STAMPINGS!



You may want a motion device that can be operated electrically—or manually. We design and produce both.

The "motion" illustrated above is one in which our research and engineering ingenuity have been applied in the development of a mechanism designed for electrical operation of an automobile door—for General Motors' experimental Le Sabre car. Just as Le Sabre represents forward-looking automotive design, so does Standard Products engineering "look ahead" in the design of special types of motion-mechanisms. We can design similar mechanisms to operate either electrically *or* manually—*or both*.

Furthermore, by employing modern mass-production and machine assembly techniques, we can make such motion devices with *stampings* . . . to keep the cost unusually low.



For further information about our facilities, write for a copy of our booklet, "We Make Motions".

THE MARK OF A SUPERIOR PRODUCT

The Standard Products Co.

DEPT. D, GENERAL OFFICES: 2130 WEST 110 STREET • CLEVELAND 2, OHIO
DETROIT SALES OFFICE: 316 FISHER BUILDING, DETROIT 2, MICHIGAN

WE MAKE MOTIONS

Gives You all — LEATHER'S STRENGTH AND ENDURANCE
RUBBER'S RESILIENCE AND RESISTANCE TO TEMPERATURE!
HOUGHTON
VIM #1243
RUBBER IMPREGNATED LEATHER PACKINGS
NEW
RESILIENCE NEVER BEFORE EQUALLED WITH A LEATHER PACKING
SQUEEZE IT!
TIGHTLY CLOSED!
SPRINGS OPEN AS BEFORE!
HOUGHTON LINE OF PACKINGS INCLUDES:
VIM LEATHER PACKINGS—Cups, flange, "U", "V"—flat washers, discs and gaskets—for oil, air, water or gas pressures—in hydraulic or pneumatic equipment, pumps, valves, etc.
VIX-SYN SYNTHETIC RUBBER PACKINGS—homogeneous and fabricated packings, gaskets and adapters, also "O" rings and VIM Leather back-up washers designed for use with them.

By an ingenious method devised by Houghton engineers, durable leather is thoroughly impregnated with tough, "springy" synthetic rubber.

Although limited in supply at present, due to allocations of raw materials, this new development is definitely the packing of tomorrow, combining the outstanding benefits of both leather and rubber.

Advantages LEATHER Offers:

- Low coefficient of friction
- Longer life
- High resistance to abrasion, extrusion and cold vulcanizing

Benefits RUBBER Provides:

- Perfect Seal
- Resistance to heat, oils, solvents
- Exceptional pliability
- Ease of installation

Houghton VIM #1243 Leather Packings—already in use for several years—are performance-proved! They are supplied in "V" and Cup Types, on rated orders, in standard sizes only. For full details, write E. F. Houghton & Co., Philadelphia 33, Pa.

. . . products of

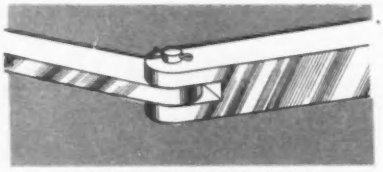
E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

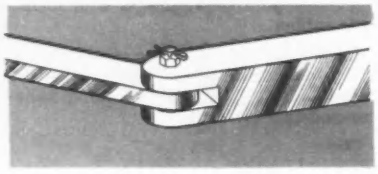
Ready to give you on-the-job service . . .

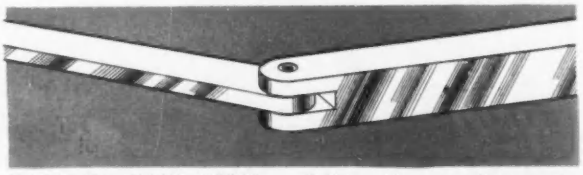
How to replace hinge pins and cotter pins with ROLLPIN self-locking fasteners

Rollpin replaces hinge pin for faster assembly of hinges. Inexpensively and simply driven in place, it cuts assembly costs. Constant spring tension holds Rollpin firm against vibration on heavy-duty automobile door hinges—on lightweight sheet metal hinges for meter or instrument panel covers.



IF YOU DO THIS ▲ OR THIS ▼ . . .





TRY THE ROLLPIN WAY INSTEAD . . . Rollpins offer many advantages as pivot and clevis pins for linkages or yoke assemblies. Heat-treated to provide excellent fatigue resistance and wear characteristics, Rollpins fit flush, grip firmly in the outer or inner members, depending on your design requirements, and are simply, inexpensively pressed in place. They are faster to install than cotter pins or safety wire . . . straight edges protect workers' fingers and clothing. Rollpins are readily removed with a punch . . . can be used again and again . . . assure simplified maintenance.

USE ROLLPINS (1) To replace set screws and rivets. (2) To pin or key gears . . . pulleys . . . levers . . . knobs. (3) As locating dowels, stop pins or shafts for small gear trains.

Once you test their effectiveness you'll want the secure, vibration-proof fastening of Rollpins in your products. Write now for a sample package and full details. Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, N. J.

ROLLPIN™

A PRODUCT OF

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA

GET YOUR FREE TRIAL ASSORTMENT OF ROLLPINS.

Mail this coupon now.

Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, N. J.

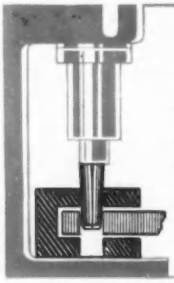
Please send me full application data and test samples of the Rollpin.

Name_____ Title_____

Firm_____

Address_____

City_____ Zone___ State_____



HERE'S HOW ROLLPINS PROVIDE A VIBRATION-PROOF FIT

Rollpins are easily pressed into production drilled holes — chamfered ends facilitate automatic or manual insertion.

Rollpins compress as they are driven — are self-retaining in production drilled holes—fit flush. Secondary hole-reaming or riveting operations are eliminated.

Constant spring tension against walls of hole lock Rollpins permanently in place until deliberately removed with a pin punch. Rollpins don't damage the hole and can be used again and again.

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

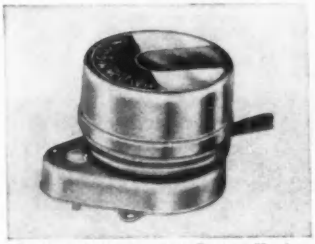
"Bridgeport" BRAND MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Gears, bushings, coil, motor cover, pinions and copper shading rings used in 400-cycle synchronous timing motor.—Courtesy Haydon Mfg. Co., Inc., Torrington, Conn.

Synchronous Timing Motor Designed for 400-Cycle Current

The use of 400-cycle current by the military and industry for many types of servo mechanisms and in communications systems brought about the design and manufacture of the illustrated synchronous timing motor.

The motor is used in time delay relays, elapsed time indicators, potentiometer controls, and sequence, interval and repeat cycle timers. Many other special timers have been or are being developed to utilize this motor.



Synchronous timing motor.—Courtesy Haydon Mfg. Co., Inc., Torrington, Conn.

Only frequency control is necessary to insure accurate timing since the motor is not affected by variations in temperature, altitude, supply voltage and load within the operational limits of the motor itself.

Self-Starting Insured

The motor is essentially two phase with two coils, cores and interlacing field pieces. To insure self-starting, a capacitor is put in series with one coil, thus giving this coil a leading flux effect.

Copper Alloys Widely Used

As in all electric motors, copper and copper-base alloys are widely used not only for their electrical characteristics but for corrosion resistance and ease of working or machining.

The motor cover is cartridge brass (70% copper and 30% zinc) which can be readily worked, has good corrosion resistance and a tensile strength of 76,000 psi in the hard-drawn condition. The cover is cupped, drawn and trimmed, then stamped with the company name and other information.

Since shading rings must have high electrical conductivity, electrolytic tough pitch copper 99.9% pure is used because of its 98-100% conductivity.

Self-Lubricating Bearings

Rotor bearings are of graphite bronze, which was selected for its self-lubricating properties. However, for the output bearing where long life and strength is demanded under comparatively heavy loads, commercial bronze is the choice. This alloy contains 89.5% copper, 8.5% zinc and 2% lead, which increases the machinability considerably. Many standard gear combinations are available to give varying output speeds depending on the timing involved.

Wheels of Clock Brass

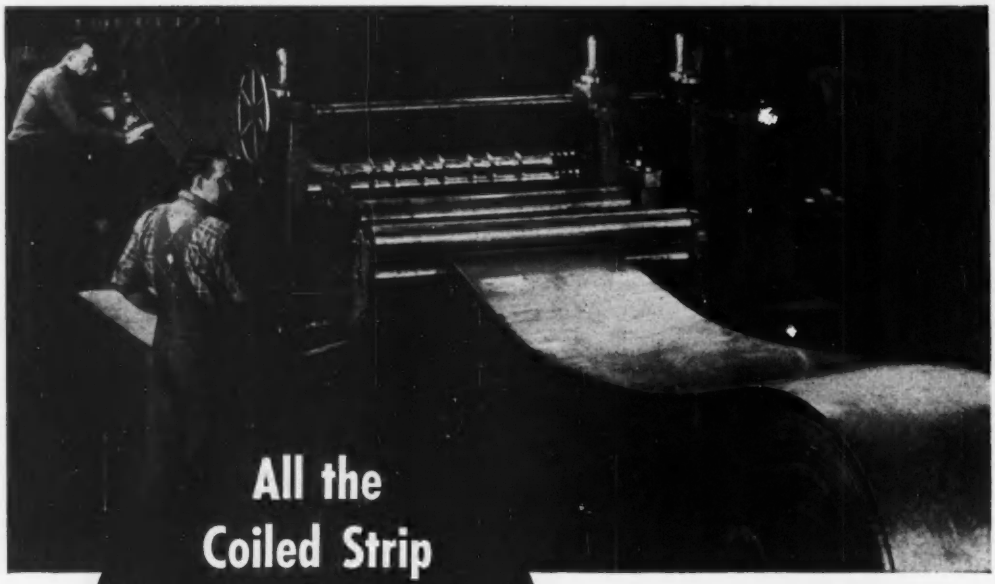
The wheels (gears) are made from clock brass (66% copper, 2% lead, and remainder zinc). The lead helps to eliminate burrs in machining the gear teeth and in blanking and piercing the wheels. Since the lead exists in the metal as small globules, some lubrication is obtained as the lead is burnished over the surface of the teeth while in operation.

Two alloys are used for the pinion gears depending on the load put on them.

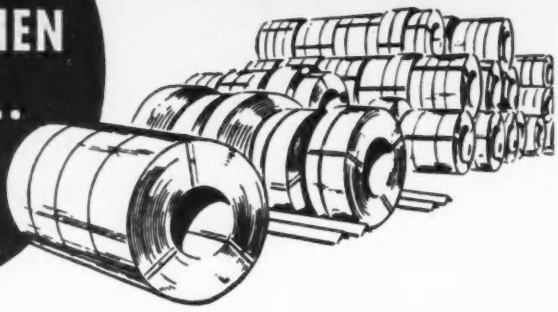
Free cutting brass rod (61% copper, 3.4% lead and remainder zinc) permits clean drilling and machining of the pinions and gives long life under relatively light loads. When the loads are greater, a leaded phosphor bronze is utilized. (7496)

New Publication Available

"Bridgeport Alloys—Properties and Uses"—new 4-page folder designed to help the metalworking industry and other fields to distinguish between copper base alloys. Lists 65 commonly used Bridgeport alloys, their composition, properties, forms and typical uses. Write to our Sales Promotion Service.



All the Coiled Strip You Need...WHEN You Need it... At LOWER COST!



You will find it ever so much easier to have all these things when you install a Yoder Rotary Slitter. The sources of supply of mill-width stock are obviously much more numerous, prices per ton much lower, and deliveries much quicker than on slit-to-width strands.

Not only that, but your stock becomes more flexible—goes farther—when mill-widths can in a few hours be slit to the desired widths in your own shop. Many fabricators have reduced inventories from 40 to 60% by investing in a Yoder slitter.

Production planning becomes easier, too, when expected and unexpected needs for any width can be so quickly and easily met.

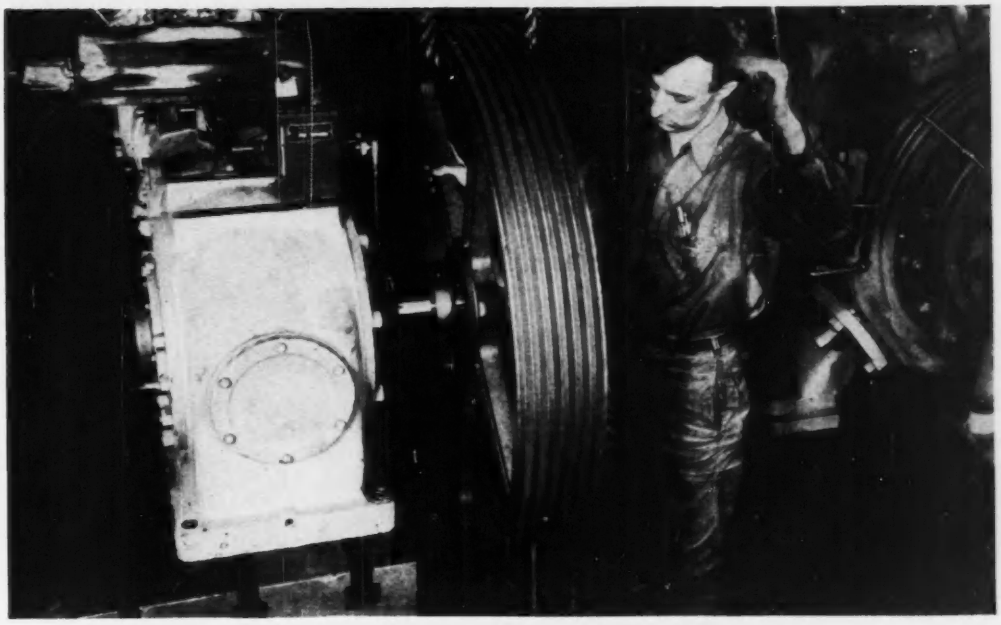
Besides all these advantages, direct savings may range from $5.00 to $50.00 per ton, depending on widths, quantities and other factors. On requirements as low as 1000 tons per year, a Yoder slitter often becomes a most profitable production tool. Get the facts! Send for 78-page book on the Economics as well as the Mechanics of doing your own slitting.

THE YODER COMPANY • 5522 Walworth Avenue • Cleveland 2, Ohio

Complete Production Lines

- ★ **COLD-ROLL-FORMING and auxiliary machinery**
- ★ **GANG SLITTING LINES for Coils and Sheets**
- ★ **PIPE and TUBE MILLS–cold forming and welding**

ENGINEERING YODER MANUFACTURING



Specify The V-Belt Sheave

which all industry likes best

QD
TRADE MARK Pat. No. 2269821

Split hub is clamped to shaft. Heavier taper-bored rim slides easily over tapered hub—no keyway obstruction on cone surface. Positive press fit on shaft. Large, long pull-up bolts also used as jack screws to remove rim.

Here's a 26-word description of the V-belt sheave that is used more than any other.*

Two parts for easy handling—separately or together. Split hub and taper-mated rim make mounting easy. No realignment problem—clamped hub stays put while changing rims.

That's Worthington's QD—the original tapered cone-grip sheave that's preferred by men who have to install or change sheaves. The QD is *easy to get on, easy to get off, yet always tight on the shaft*—tighter than any other sheave on the market. Hubs for every bore—lower inventory cost.

For your machines, pick Worthington Multi-V-Drives with QD sheaves and Worthington-Goodyear EC Cord V-belts.

Worthington's complete line also includes FHP drives—QD Junior (quick-detachable) V-pulleys and many other styles.

Send coupon for Bulletin V-1400-B7F, addressing our Harrison office.

**In addition to being one of the largest-selling sheaves, the popular Worthington QD design is licensed to many other sheave manufacturers. For your customer's protection, dimensions are standardized to permit interchangeability*

MV.1.8

WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power, rotary, steam

AIR COMPRESSORS: water-cooled, air-cooled

Worthington Pump and Machinery Corporation
Multi-V-Drive Sales Division
Buffalo, New York

Send Bulletin V-1400-B7F on Worthington Multi-V-Drives.

Name .....

Company .....

Address ..... Zone ..... State .....

STANDARDIZE WITH OHIO

Long experience, coupled with most modern equipment, combined with quality materials go into each Ohio Gear and Ohio Speed Reducer. Every detail of product and workmanship is designed to insure accuracy, durability and smooth operation.

The materials regularly used are those which have proved to be most satisfactory for general use under average working conditions. Type of gear, size and nature of application are some of the factors determining the material selected for any given gear. Check for dimensional accuracy is made at each step of manufacture and rigid tests and inspections of the finished gear by experienced shopmen detect any inaccuracy and establish fidelity of specifications in every detail.

In the cutting of Ohio Gears and construction of Ohio Speed Reducers, the components have higher than average strength factors for long life, lower up-keep and operating cost.

Illustrated above are a few applications by large manufacturers who depend on Ohio Gear.

1. Ohio Gear DPL Speed Reducer operating a paint booth turn-table in a large metal working plant.
2. Ohio DS Speed Reducer, 300 to 1 ratio, used in the drive of a machine which automatically welds both heads into the shell of a 55 gallon barrel.
3. Ohio Gear DHU Speed Reducer operating an overhead scrap conveyor belt in a large die casting plant.
4. A PL2 Reducer, 40 to 1 ratio, operating the turn-table of a machine automatically welding automobile crankshaft vibration dampers.
5. Series of Ohio Gear HS Speed Reducers operating conveyors in a California fruit packing plant.
6. Detroit RotoGrate Industrial stoker using an Ohio DHH2 Speed Reducer as part of auxiliary equipment.

Consult your nearest distributor or write us for complete information.

ESTABLISHED 1915

OHIO GEARS

THE OHIO GEAR COMPANY

1325 EAST 179 STREET
CLEVELAND 10, OHIO

GREATER ELECTRICAL AVAILABILITY YOURS WITH

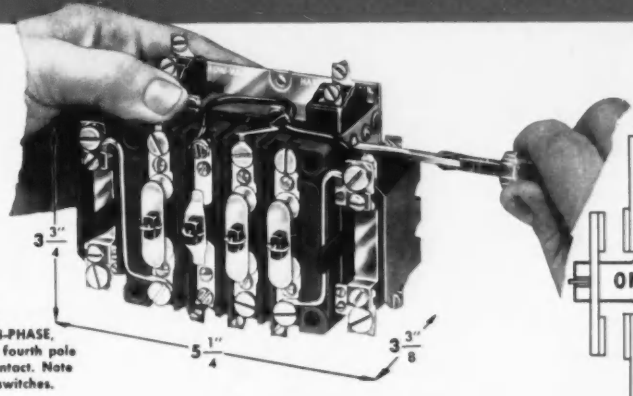
ARROW AH HART

TYPE "RA" RIGHT ANGLE ADVANCED DESIGN MOTOR CONTROLS

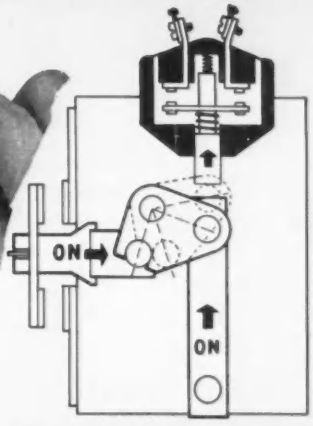
- JUST ½ THE SIZE • ½ THE WEIGHT
- BETTER PERFORMANCE
- 55% GREATER ARC RESISTANCE
- 30% SAVINGS IN INSTALLATION
- EASY TO WIRE AND TO INSPECT
- AVAILABLE IN SIZES 0, 1, 2, 3 and 4 IN NEMA Enclosure Types I, IV, V, VH, IX

SIZE 1, LOCAL CONTROL

PLUS EXCLUSIVE ELECTRICAL INTERLOCK



SIZE 1, REMOTE CONTROL, Standard 3-PHASE, employing fourth pole holding contact. Note auxiliary switches.



Schematic pictures "RA" mechanism trip arm that automatically energizes interlock switch.

NO OTHER STARTER PROVIDES THIS VERSATILITY

Arrow-Hart's "RA", right angle, balanced mechanism with bellcrank fulcrum assures simple and positive force to operate the A-H auxiliary switch or switches. JUST TWO SCREWS and a completely enclosed electrical holding interlock switch provide dependable operation of numerous interlocking device combinations or signal lights. Men confronted with adding more circuits to serve more needs in restricted space have accepted and are benefiting from the many outstanding features of the A-H Type "RA" line of motor controls. Buy an Arrow-Hart starter today and see for yourself.

BUY WITH CONFIDENCE PROFIT BY PERFORMANCE

THE ARROW-HART & HEGEMAN ELECTRIC CO., HARTFORD, CONN., U. S. A.

ELECTRICAL CONTROLS

ARROW AH HART

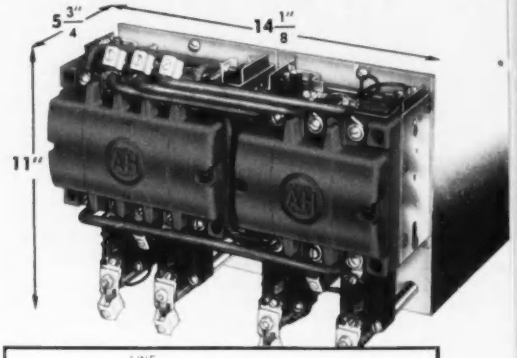
ESTABLISHED IN 1890

GREATER SAVINGS IN SPACE IN TIME IN DOLLARS

WITH ARROW AH HART TYPE "RA" MAGNETIC STARTERS

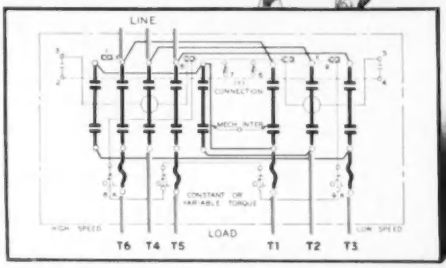
AVAILABLE WITH EXCLUSIVE AUXILIARY SWITCHES

The Arrow-Hart motor control line is out front with an advanced design to provide industry with greater performance in smaller space. Adaptability is found in permitting the interlocking of numerous devices by means of a rugged and compact auxiliary switch. Another A-H exclusive, this utility switch is inserted from the top and requires but two screws for effective operation. The auxiliary is operated through contact with the operating lever arm of the "RA" mechanism. All auxiliary switches mount easily and quickly in one position.



THREE BASIC TYPES

Available in standard with BLACK button (one normally open), with RED button (one normally closed), and with GREEN button (one normally open and one normally closed). All auxiliary interlock switches are properly identified to aid in selection and safe application. One BLACK button (normally open) switch is furnished as standard on most motor starters.



TYPICAL INSTALLATION

Pictured to the right is a typical application of A-H auxiliary switches used in conjunction with an Arrow-Hart Size 3, 3-phase, 2-speed reconnected winding type of control. Note easy access to terminals and the big advantages of straight-thru front wiring. Additional information appears on the preceding page.

"RA" LINE A COMPLETE LINE

The patented "RA" design is available in magnetic starters and contactors in Sizes 0, 1, 2, 3 and 4 as units for panel installation or in NEMA enclosure types I, IV, V, VII and IX. The Explo-Safe line of explosion-proof housings features a Feraloy casting of new design at greatly reduced weight and bulk. There are "RA" controls to serve you best.

Available as Starter Units or in NEMA Enclosure Types I, IV, V, VII, IX

ARROW·HART

INDUSTRIAL CONTROL DIVISION

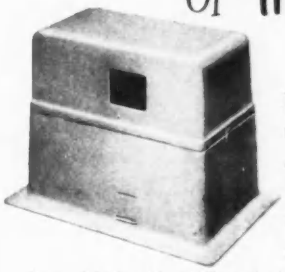
WRITE TODAY for bulletins describing Standard, Explosionproof and Weatherproof Motor Controls.

THE ARROW-HART & HEGEMAN ELECTRIC CO., 103 HAWTHORN ST., HARTFORD 6, CONN., U.S.A.

Branches in BOSTON, CHICAGO, CLEVELAND, CINCINNATI, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, SYRACUSE. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO.

PRINTED IN U.S.A.

The Tale of the Tougher Meter Housing



Rugged enough to take all the use—*or abuse*—you and the weather can give it, this attractive outdoor Meter Housing is molded with a Fiberglas† reinforcement.

Ten times lighter than the concrete unit it replaces, this housing protects costly utility meters and regulators from the ravages of weather, water, and soil corrosion . . . helps them give better service with less maintenance.

Zenith Plastics Co., Gardena, Cal., the molder, is just one of the many alert manufacturers who are making increasing use of Fiberglas-reinforced plastics to make a host of civilian and military products, such as washing machine parts, boats, fishing rods, aircraft components, and military instrument cases.

If you're looking for a unique new material that combines high strength, with light weight . . . that won't rot, rust, or absorb moisture . . . that is adaptable to volume production . . . then Fiberglas reinforcements are for you. Write today for details: Owens-Corning Fiberglas Corporation, Reinforced Plastics Division, Dept. 807, 16 East 56th Street, New York 22, N. Y.

*it's Plastic, reinforced with OWENS-CORNING FIBERGLAS Yarns

FIBERGLAS IS IN YOUR LIFE... FOR GOOD!

† Fiberglas is the trade-mark (Reg. U.S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibrous glass.

For Defense or Essential Civilian Use—

get the mo$t for your Zinc Die Ca$ting Dollar!

OBTAIN COMPLEXITY OF SHAPE AT LOW COST

Whether that new product is destined for essential home front consumption or for military use, investigate the cost-saving features of ZINC Die Castings for the critical metal components. The fuze body and the delay housing of the well-known hand grenade are excellent cases in point.

All during World War II the ZINC Die Castings pictured at the right below met the demands of unfailing performance in the "pineapples," and now they again are specified for the same critical components of the grenades in current production.

Although complex in shape, these castings are produced at high speed in multiple-cavity dies, with only one machining operation required on each piece prior to assembly—an internal thread is machined in the fuze body and a hole is broached in the delay housing. Not only are all holes and recesses cored, but the external threads on the delay housing also are obtained in the casting operation. By any other means of production more parts would be required, or secondary operations would be excessive.

GET DESIGN INFORMATION

Any die casting company will be glad to help you in adapting the design of a part to its most economical production by the die casting process. Also ask us—or your die caster—for a copy of "Designing for Die Casting" and other booklets covering specific phases of ZINC Die Castings.

The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

Always the same . . . product quality that never varies . . . that's the secret of Aeroquip's leadership. Nothing is spared in time, money and effort to obtain the newest, most accurate inspection equipment to assure the Aeroquip standard, highest in the industry. That is why Aeroquip Products are "Always First" in quality.

- Flexible Hose Lines
- Detachable, Reusable Fittings
- Self-Sealing Couplings
- Breakaway Couplings

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Smart
Standard Steel Works
Forged Pinion Blank
Machined Pinion,
ready for instal-
lation.
Reduction Gear—
Standard Steel Pinion
Blanks have the nec-
essary uniformity and
high physical prop-
erties for applications
like this.
BALDWIN
BLH
LIMA-HAMILTON
BALDWIN

operators cut their teeth on

STANDARD STEEL WORKS

forged pinion blanks

The high cost of machining a stub axle pinion like this makes it imperative to *start* with a blank that is free from flaws and completely uniform in structure.

That's why these Standard Steel Works blanks are made with such particular care. They start with steel produced in Standard's own open hearth furnaces, where the most rigid control of analysis can be consistently maintained. Forging, on one of the battery of presses or hammers, develops superior physical properties, and refines the grain structure. Heat treating in special furnaces relieves strains, and adds an important plus to service qualities. Close dimensional tolerances reduce machining time and waste.

It is always well to remember that a gear can't be any better than the blank . . . and that getting a better blank is the surest way to assure minimum machining and maximum service. You'll find Standard an ideal supplier: big enough to handle the most particular jobs, small enough to make every job a matter of personal concern.

ALSO . . .

FORGED WELDLESS RINGS FOR RING GEARS

Uniform structure permits precision machining, assures uniform strength. No welded areas to affect tooth physical properties or finish.

FORGED BLANKS FOR GEARS

Pressed die forgings for gear blanks provide the strength, toughness needed in heavy duty service. Conformity to design tolerances saves machining.

NOTICE: DESIGN AND PURCHASING DEPARTMENTS—Standard is equipped to supply pinion blanks in any size that can be worked under a hammer . . . weldless rings up to 12 feet diameter . . . and pressed die forgings up to 50 inches diameter. Make a note to let us quote on your requirements.

STANDARDIZE ON STANDARD for

GEAR BLANKS, STEEL CASTINGS, FORGINGS,

WELDLESS RINGS, FLANGES

STANDARD STEEL WORKS DIVISION

Burnham, Mifflin County, Pennsylvania

·LIMA·HAMILTON

SQUEEZE PLAY

35 ton "Hy-Power" Riveter attaching brake backing plate assembly to rear axle housing with cold rivets.

. . . on assembly costs

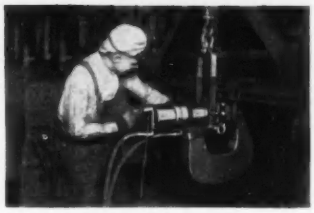
Yes, you can really put a "squeeze play" on assembly and production costs with a Hannifin silent-squeeze "Hy-Power" Riveter. It can take over your riveting operations—and many types of pressing, punching, forming and bending jobs—do them silently with push-button ease and efficiency that up production, reduce cost.

Heart of the "Hy-Power" hydraulic system is the unique "Hy-Power" Generator—a combination of motor, pump, oil reservoir, control valves and high pressure intensifier assembled as a compact, self-contained unit.

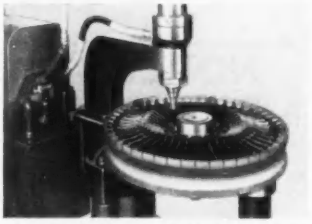
It powers the "Hy-Power" Riveter—the work tool that silently forms cold rivets at the touch of a button.

For a thorough discussion of how "Hy-Power" equipment can be utilized best in your plant, ask to have a Hannifin field engineer arrange an appointment with you.

Also, WRITE FOR YOUR COPY OF BULLETIN 150—*"Hy-Power" Hydraulics* Hannifin Corporation, 1125 S. Kilbourn Avenue, Chicago 24, Illinois.



One man handles this 50-ton "Hy-Power" Riveter with effortless ease in working on railroad car underframes.



A stationary "Hy-Power" Riveter joins hub and runner assembly of hydraulic couplings.

do ALL you CAN do . . . with

HANNIFIN

Air Cylinders • Hydraulic Cylinders • Hydraulic Power Units • Hydraulic Presses • Pneumatic Presses • "Hy-Power" Units • Air Control Valves

NOW YALE CAM LOCKS

FOR YOUR METAL CABINETS

CAPPED WITH STAINLESS STEEL

It's the same fine lock with the same fine quality name plus a new permanent surface!

• It's better! *But no more expensive*—better looking, better engineered. It licks the problem of plating on die-casting through the use of a stainless steel scalp.

This new idea—in the Yale line of cam locks gives you another good reason for specifying Yale for every metal cabinet job. For here is a long-lasting beauty treatment that will add to the attractiveness of your cabinet and, of course, give you Yale lock security. For detailed information write The Yale & Towne Manufacturing Co., Dept. S-2212, Stamford, Conn.

YALE & TOWNE

YALE is a registered trade mark.

"I read PRODUCT ENGINEERING because, as a busy engineering executive, I find it keeps me informed of what other industries are doing in modern methods and materials."
Says Mr. G. D. Simonds,
Chief Engineer,
The Four Wheel Drive Auto Co.
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He Designs
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Everywhere in your giant Original Equipment Market,*

PRODUCT ENGINEERING sells the top men at "Design-Engineering Headquarters."

Sales-conscious advertisers of parts, materials, components and finishes long ago put these two facts profitably together: by far their biggest, and fastest-growing, market is the giant *Original Equipment Market* . . . and in selling to this market there is no substitute for the proved sales power of PRODUCT ENGINEERING.

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Edited *exclusively* for the engineers who design every new machine, appliance, or other engineered product . . . this is the *only* design magazine these basic buyers of original quipment voluntarily seek, and pay to read. And because they can get from no other source the job help this magazine provides . . . over 18,000 top men in industry's Design-Engineering Headquarters are PRODUCT ENGINEERING subscribers . . . self-elected *readers* . . . and improvement-conscious shoppers in its advertising pages.

Get *all* the facts about PRODUCT ENGINEERING . . . and you'll *know why* concentrated advertising in its pages is one of the soundest investments you can make this year, next year, and every year.

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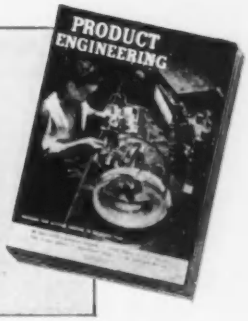
PRODUCT ENGINEERING CARRIES MORE ORIGINAL EQUIPMENT* ADVERTISING THAN ANY OTHER MAGAZINE IN THE WORLD!

*When your parts, materials, components or finishes are selected by product-design engineers for incorporation in new machinery, equipment or appliances . . . they are specified as *Original Equipment*. The *Original Equipment Market* is the big-volume, repeat-order market which offers any supplier of parts, materials, components or finishes industry's biggest sales opportunity. And advertisers place more advertising pages, and invest more advertising dollars, in PRODUCT ENGINEERING than in any other design magazine in the world because they know PRODUCT ENGINEERING gives them top coverage of the *Original Equipment Market's* basic buyers at lowest cost.



AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

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MicroRold Stainless Steel

WASHINGTON, PENNSYLVANIA PHONE: WASHINGTON 5900

JOHN C. RICHARDS
GENERAL MANAGER OF SALES

YOU CAN STILL PRODUCE STAINLESS STEEL PRODUCTS

TYPE 430 IS STAINLESS STEEL

Type 430 (straight-chrome) enables many fabricators to continue production of stainless products, by consideration of its fabricating qualities and physical and chemical properties.

HAVE YOU EXPLORED THE POSSIBILITIES OF MICROROLD TYPE 430 SHEETS?

MicroRold Type 430 offers the same fabricating advantages, such as micro-accurate thinness control, uniformity of gauge, increased product yield, longer die wear and excellent surface conditions, as characterized by the MicroRold trade name.

Our warehouse distributors are available to assist you in solving application and supply problems. Write for the name of the MicroRold distributors in your area.

Yours truly,

WASHINGTON STEEL CORPORATION

John C. Richards

John C. Richards,
General Manager of Sales

Materials ~ AVAILABILITY AND TRENDS

TRENDS IN STEEL

The trend toward more sheet and strip steel does not signal the end of the steel shortage. The supply is likely to dry up again. Sheet and strip are easy to get now because the government has allowed mills to go on producing light, flat-rolled products without much hindrance. But orders have now been issued telling mills they must shift, where possible, from sheet to plate. This is because military and defense supporting industries need more plate. The orders will reduce sheet supply in January.

Demand for structurals is easing at the mills. Important leaders in the steel industry insist this means the shortage will soon be over. But the lessened demand stems from the government clamp-down on construction, which makes it impossible to judge the underlying situation. In the meantime, structural shapes remain scarce and mobilization chiefs see nothing but a continued shortage well into 1952. Optimists among allocaters say the supply will ease somewhat the latter part of next year.

ALLOY AND TOOL STEELS

The trickle of aircraft quality alloy steels which has been going into non-military uses has been stopped. NPA ordered distributors to sell no more of them except for military or AEC purposes. At the same time, it ordered steel mills to supply distributors, beginning January 1, with a minimum of 100 percent of tonnages shipped in the base period, April 1, 1951, to June 30, 1951. This will increase the supply in distributors' stocks, but it will be available only on orders certified to be for aircraft, guided missiles, airborne equipment, or the atomic energy commissions.

Tool steels remain a bright spot. NPA is being urged to remove restrictions on its use because of adequate supply. The 40,000 tons being produced quarterly seem to be ample for any foreseeable demand.

VITAL METAL OUTPUT

The stockpile and other defense needs at least will get a shot-in-the-arm from an increase in production of cobalt, nickel and copper assured under an agreement reached by the Defense Materials Procurement Agency and the National Lead Company. Through government financing the company expects to have a new plant in operation within 18 months. It will produce these metals at an average annual rate of 1,386,000 pounds of cobalt, 1,852,200 pounds of nickel and 1,417,500 pounds of copper.

As far as any increased availability of these materials for non-defense purposes is concerned, the outlook is dark. Disarmament seems to be the only hope and such a possibility is remote.

HELP FOR ALUMINUM

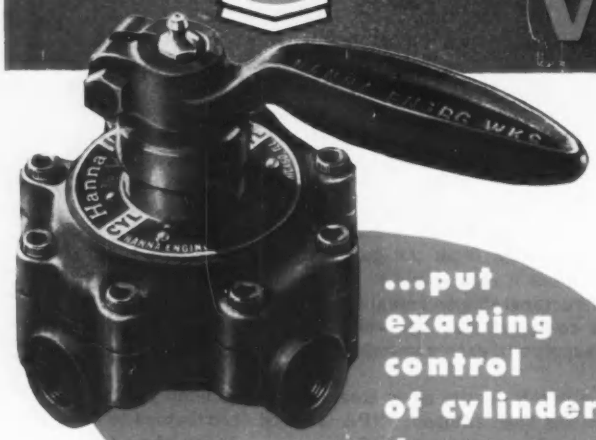
This seems to be open season for contracts between the government and materials producers. Users of basic aluminum pig and ingot are now assured of a plentiful supply of the light metal for years to come, under terms of precedent-setting contracts between Aluminum Company of America and the General Services Administration of the U. S. government.

The contract provides that the government will have first call for five years on the aluminum output of the new smelting plant being built by ALCOA at Rockdale, Texas. When monthly government requirements take less than two-thirds of the metal produced, the remainder, up to the two-thirds total, will be made available to other users of aluminum in the form of pig or ingot during the five year period.

(Continued on page 121)

Hanna® Cylinder Control Valves

Trademark of Quality

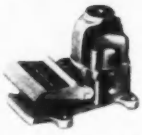


...put exacting control of cylinder power at your finger tips

Hanna Unitite Valves are designed and built to give long, trouble-free service as hand-operated cylinder control valves. They are quick-acting, packless and permanently tight. Except for periodic lubrication, they require no maintenance: (Laboratory tests have shown maintenance-free operation for 10 to 15 million cycles!)

They may be used for 3-way or 4-way operation for air, oil or water pressures up to 250 p.s.i., and are available in three mounting styles standard, column and manifold.

Foot Operated



Hanna Foot-Operated Valves are available in single and double pedal models for operation up to 250 p.s.i. for use with air or hydraulic cylinders.

Electric Operated

Hanna Solenoid Valves are available in single or double solenoid models. Momentary contact ... High speed ... Specially suited to automatic operation or remote control.

Speed Control

Hanna Flo-Set Valves have micrometer graduations to assure exacting speed control. They are available in ¼", ⅜" and ½" sizes for air, oil or water to 250 p.s.i.

Send for Catalog

New Hanna Valve Catalog No. 254 gives full information on the complete line of Hanna Valves for all circuit requirements.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

1763 Elston Avenue, Chicago 22, Illinois

At the conclusion of the five year term, such pig and ingot customers will continue to have first call on 25 percent of ALCOA's Rockdale production for an additional fifteen years. The remaining aluminum produced by the new expanded facilities will be made available to the market in the form of semi-fabricated and fabricated products.

Similar agreements were recently reached by ALCOA and GSA concerning the aluminum output of the company's new smelting facilities now being built at Wenatchee, Washington, and of two additional smelting lines currently being built at Point Comfort, Texas.

The metal being made available under this program by the aluminum industry to pig and ingot customers in future years will amount to considerably more tonnage annually than the maximum ever purchased by such users from American aluminum-production lines in the past.

PLASTICS PICTURE UNIQUE

The plastics picture has indicated a unique change for these times, according to Mr. Sollenberger of NPA. The materials shortages which previously existed appear to have been corrected by production increases, but there has arisen a softening of demands for plastic parts. It is possible that the predicted brighter outlook for steel and aluminum has dampened the enthusiasm for plastics as substitute materials.

Supply of polyethylene, now running far below demand, will be cut in February when one of the big producers shuts down to install new equipment. Output is now running a fourth greater than a year ago. Direct military is getting more than a third of the supply; a fourth is going for essential civilian uses like covering wire and cable. The free market is getting twenty-two percent of output. Chances are this will be increased between now and the February shut-down but not enough to end the shortage. The outlook is for relief late next year.

Polyester resins, fluorinated ethylene polymers, and resorcinol resins are expected to remain tight because of anticipated military demands. Other plastics are in fairly good supply. Some polystyrene processors are reported to be turning down offers of materials.

COMPONENTS OUTLOOK

The outlook for components was improved by an increase of first quarter materials allocations to the general components division of NPA. The increase puts the division back to the third quarter level, wiping out a cut imposed for the current quarter. It won't change the picture to one of plenty, however. Components shortages have the top mobilization planners worried. They figure on scheduling components production in some lines, as they do now for types of steel. Unless more skill is shown than with these basic metals, components would be harder, not easier, to obtain during the shake-down period.

Maintenance of distributors' stocks of components is a particular worry. One group in NPA wants to put distributors on a full allocation system. Their argument is that such an order is needed to keep normal trade channels full. Without one, they think the supply of components will dry up for everyone except producers of direct military goods.

STANDARDIZATION

Government-invoked standardization will sharply reduce the variety of components and standard parts. It will wipe some products off the market, if current plans are carried out. A return to conservation orders of World War II type is planned. Order L-278 of War II cut the number of pipe fittings from almost 39,000 to 3,600. Planners claim it saved 3,500 tons of alloy steel a year, 175 tons of chromium, 17 tons of molybdenum. They credit it with a ten percent increase of production by eliminating short runs. They have similar standardization orders under consideration at present.

SPEED NUTS score "direct hit" on Globe Jet Target

How SPEED NUTS "shot down" cost of assembly, saved time and ended vibration-loosening problems on Globe Jet Powered aircraft targets.

Speeds attained by the Globe KD2G-2 jet target are high enough to provide the realistic touch of actual air-to-air or air-to-ship attacks. This sleek craft is the result of over three years of development work by Globe Corporation, Aircraft Division, Joliet, Illinois, in cooperation with the Navy Department, Bureau of Aeronautics.

Globe engineers had to plan assembly of the target with fasteners that could take intense vibration. Of all those tested, Tinnerman SPEED NUTS made the biggest hit. *Not only did SPEED NUTS end vibration loosening problems, they also provided an average time-savings of 48% per application over other methods.*

Globe is justifiably proud of the jet target, one of the achievements that stands out in its 50th anniversary year. And Tinnerman is proud of its part in this success. Perhaps your company can use the valuable experience gained by Tinnerman on this and many other projects. Write for information on our comprehensive Fastening Analysis Service. TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. In Canada: Dominion Fasteners Limited, Hamilton. In Great Britain: Simmonds Aerocessories, Limited, Treforest, Wales.

SPEED CLAMPS attach hose to fitting of internal fuel line. Note low profile of one-piece clamp.
Tail cone is attached with 5 "U" type SPEED NUTS which hold themselves in bolt-receiving position for blind assembly.
More than 23 SPEED NUTS are used in various locations on the KD2G-2 target. They must hold tight under vibrations created by the jet engine pulsating at 70 to 80 cycles per second, catapult shocks of 10 to 15 g's acceleration, and the impact of parachute landings at end of each mission.
"AN" receptacles on junction box are secured by SPEED NUT retainer rings.
TINNERMAN Speed Nuts
FASTEST THING IN FASTENINGS

The Easy Way Out

It has been proposed that "the government" subsidize the education and training of engineers and thereby wipe out the shortage. Thus the educators are to join the growing army that is living on subsistence. Nothing is said about the increased taxes that would be required to meet the bill. Presumably it is expected that a country that can send four billion dollars to foreign lands to alleviate suffering must also take care of its own man power problems. And thus the merry-go-round continues.

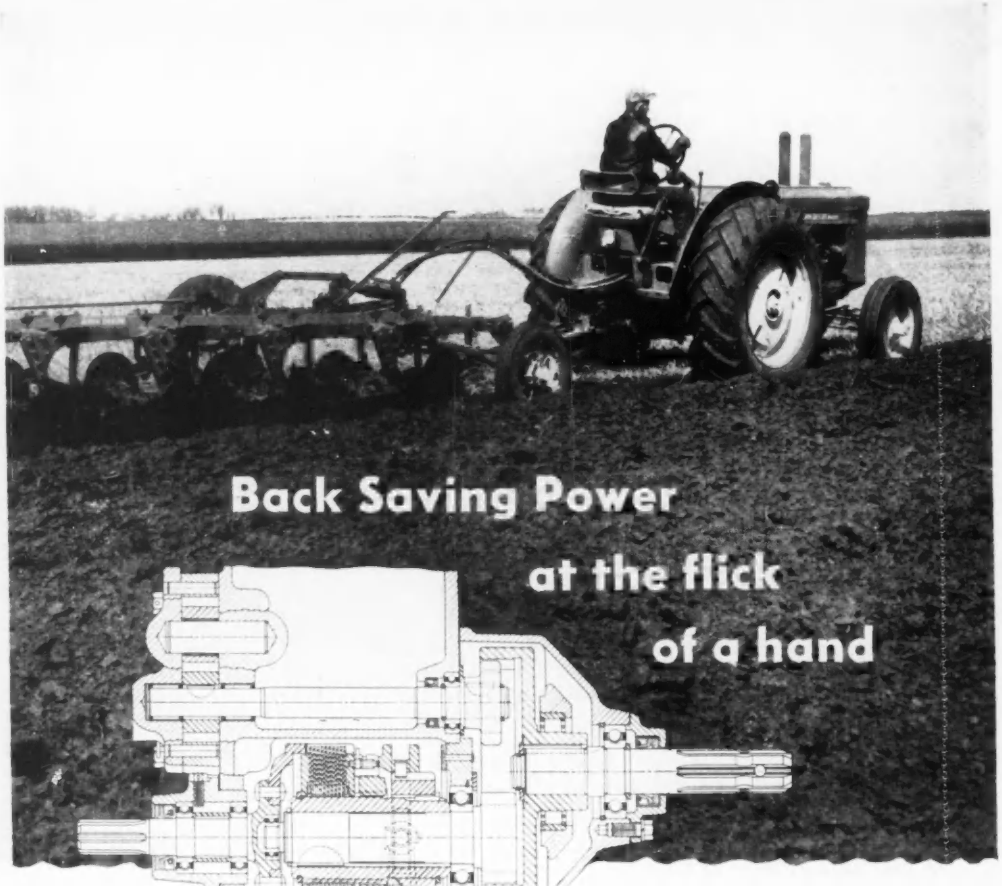
Ironically, the present financial difficulties that are hampering the colleges are caused by the trends to socialism, the heavy tax burden to support subsidies, and the extravagance, wastefulness and corruption in government operations. And the greater the sums of money involved, the greater the opportunities for graft and corruption and the more wasteful the nation becomes.

With taxes gobbling up personal and corporate incomes, private contributions to colleges are getting smaller and the colleges' income from their investments is also less. It is freely predicted that the privately endowed colleges are doomed. When and if they are taken over by federal government, elected and appointed federal politicians will have much influence and authority in directing our education. That will be the biggest step toward statism, second only to the loss of freedom of speech and press. It is disheartening indeed to hear leading educators beg for money from the federal government.

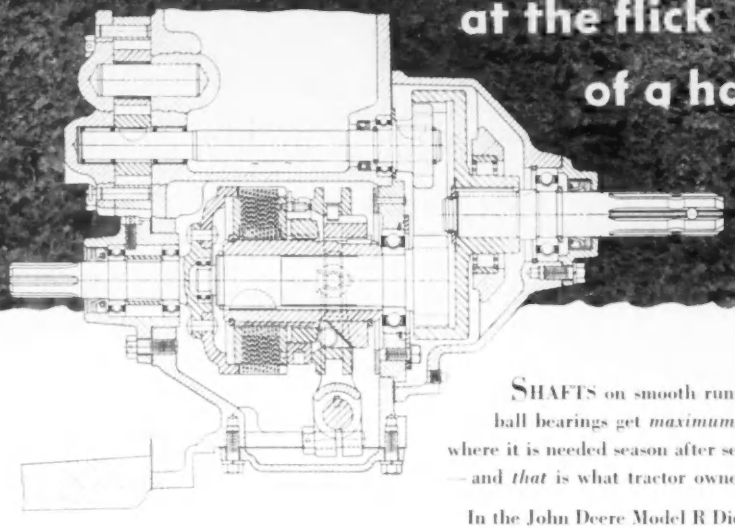
One solution of our college support problems is through support by industry and the individual states, the state government and personal contributions from friends and alumni. Once the problem is dumped into the lap of the federal government the shenanigans begin.

The situation with respect to the colleges is merely another example of the growing chaos that is developing in our national affairs. And the biggest contribution that the colleges can make is to do more teaching concerning the virtues of honesty, the penalties of dishonesty and the fact that there is no such thing as getting something for nothing. The easy way out, the quick solution, the fattest return in dollars is undoubtedly to get Uncle Sam to subsidize education on a vast scale. But the inevitable price in terms of academic freedom, personal dignity and squandered money as measured by taxes, is awesome to contemplate. Regrettably, he who seeks an easy way out usually does not do much contemplation. It may be too uncomfortable.

G. F. Zodenholt



Back Saving Power at the flick of a hand



Direct engine-driven Power Take-off and Hydraulic "Powr-Trol" pump for operation of attachments to the John Deere Model R Diesel Tractor are engaged or disengaged at will by an independent clutch.

SHAFTS on smooth running New Departure ball bearings get *maximum* power right thru to where it is needed season after season without change — and *that* is what tractor owners really appreciate.

In the John Deere Model R Diesel, New Departures on the independent clutch, power take-off and hydraulic pump shafts assure back saving power at the flick of a hand for raising, lowering, angling or driving of attachments.

New Departure, Division of General Motors Corp., Bristol, Connecticut.

Nothing Rolls Like a Ball

NEW DEPARTURE BALL BEARINGS

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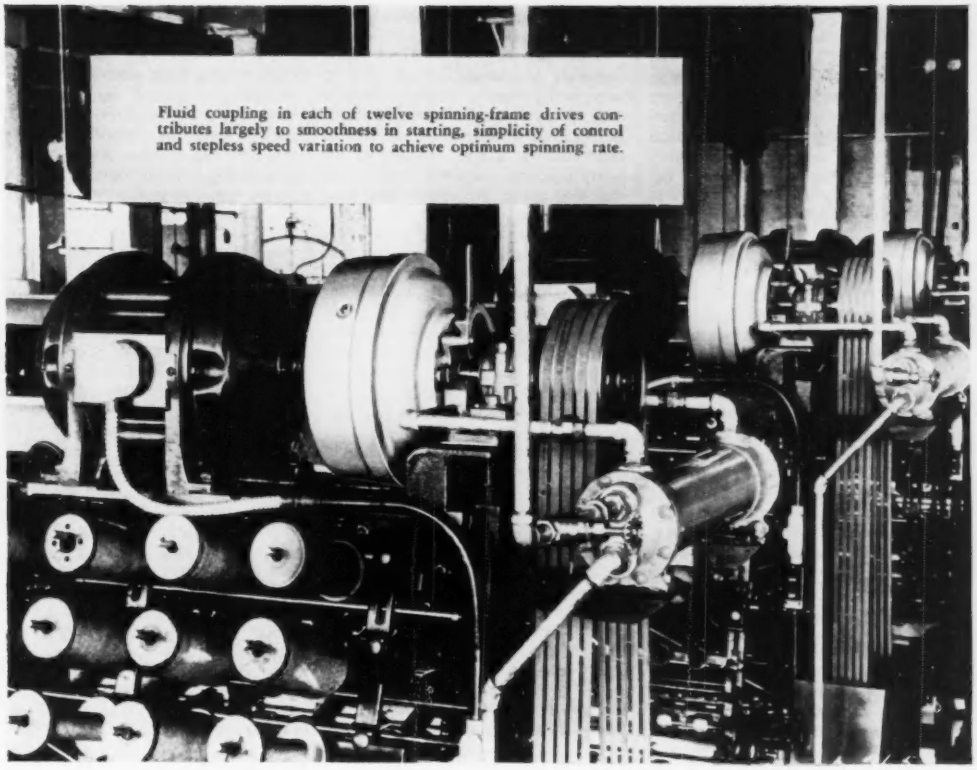

Fluid coupling in each of twelve spinning-frame drives contributes largely to smoothness in starting, simplicity of control and stepless speed variation to achieve optimum spinning rate.

Which Variable Speed Fluid Coupling?

R. C. HABICHT
American Blower Corporation

THE METHOD OF MATCHING a fluid coupling to a driven load has been discussed, in principle, in a previous article (PRODUCT ENGINEERING, October 1950). However, this procedure must be varied if the coupling is a variable fill, rather than a traction or constant fill type.

Basically, the operating principles of the variable fill coupling are the same as those for a traction type. In both, power is transmitted from the impeller to the runner by a vortex of oil. In both, with constant diameter and slip, the torque transmitting capacity varies as the square of the speed, and power transmitting capacity, as the cube of the speed; with constant slip and speed, power transmitting capacity varies as the fifth power of the diameter. The difference between the two is that the variable fill or dump coupling is so designed that the quantity of oil remaining inside the coupling can be regulated while unit is operating. Thus the variable fill coupling can be used for controlled acceleration, for speed regulation and as an adjustable safety device under stall conditions.

Several devices are used in coupling

circuits for obtaining speed adjustment, among which are external oil pumps, leak-off ports, sliding scoop tubes and control valve arrangements. The size, speed and horsepower of the drive are all taken into consideration to determine which method is most practical for a given duty range. Fig. 1 shows the scoop-control type, which is designed to operate from 5 to 250 hp at 1,800 rpm and less in a series of sizes from $9\frac{1}{4}$ to 36 in. in diameter.

In the scoop type coupling, fluid is continuously bled from the working circuit through leak-off ports to the rotating oil reservoir and held in an annular ring within the reservoir by centrifugal force. The scoop tube skims oil from this ring and delivers it through a manifold to an external oil cooler from which it returns to the working circuit.

The position of the scoop tube tip determines the amount of oil in the rotating reservoir. If the scoop tube is extended to the outermost position, no oil remains in the rotating oil reservoir. Therefore, all of the oil is in the working circuit, which includes the oil cooler and connecting piping. Under these conditions, the coupling operates at minimum slip. As the scoop tube is moved toward the center or inner position, the reservoir is allowed to fill with oil. This action reduces the amount of oil remaining in the working circuit, causing the speed of the output shaft to decrease and the amount of slip to increase.

There are many applications where operating conditions would lead to overheating were a traction coupling used. A conveyor, for example, might be required to start and stop two or three times a minute. Because of the heavy heat load imposed by this rapid start-stop cycle, the correct size traction drive might not have enough surface area to to dissipate the heat generated in the oil. A larger traction drive with more surface would be too large for the load and afford little or no protection for the motor and driven equipment. A practical solution to this problem is to use a variable speed coupling of appropriate size with an oil cooler selected to handle the load.

In a new installation, the final operating conditions are not always known or is it anticipated that the operating conditions will be changed in the future. Fig. 2 shows a Size 15 scoop control fluid drive rated at 40 hp and 1,750 rpm on a rolling mill. This machine consists of a progressive series of dies for forming steel strip into channels and is designed to handle from 12 gage up to $\frac{3}{16}$-in. stock. A different amount of oil is required for each gage of steel processed. The scoop tube can be set to give the required breakaway torque and then reset for the desired operating condition. Draw benches and extruders are similar applications where this flexibility of operation is desirable.

On certain rotating machinery with high inertia, it is often necessary or desirable to extend the acceleration time up to as much as 15 min. A traction type drive would be impractical for two reasons. First, the heat load during this prolonged acceleration period would be prohibitive. Secondly, the traction coupling with reduced oil filling for the desired acceleration rate would not have the correct oil filling for full speed operation. With an adjustable speed drive, the scoop control lever can be operated, either manually or automatically, to give the desired acceleration rate, and then adjusted to the correct oil filling for full speed operation. During the acceleration period, the heat would be continuously rejected through the external oil cooler.

Selection Factors

There are several factors that influence the selection of a variable speed coupling for a given application. These factors are: (1) Speed and horsepower at maximum speed, (2) horsepower characteristics at reduced speed, (3) type of load and (4) maximum speed reduction required.

The maximum horsepower and speed are used to determine, hydraulically, the correct size. The scoop-control coupling selection chart, Fig. 3,

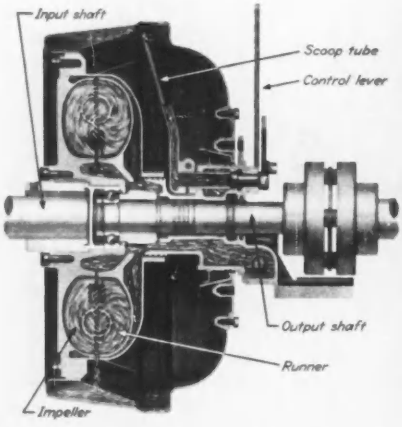

Fig. 1—Essential components of scoop-control type coupling. Movement of control lever shifts position of scoop tube to vary output speed by changing volume of rotating oil.

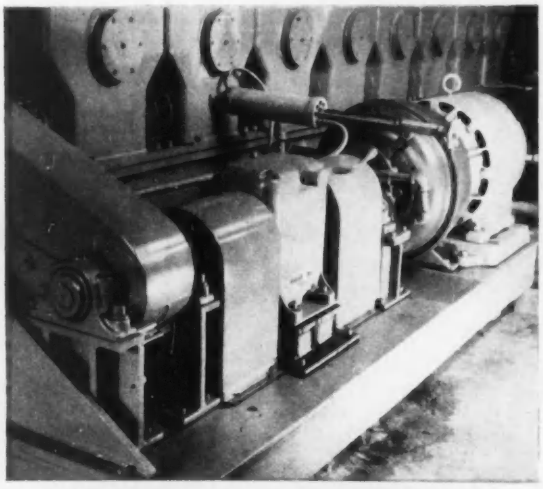

Fig. 2—Adjustability of scoop-type coupling simplifies setting of correct torque on a rolling mill when forming different gages of steel strip.

is based on selections having a minimum slip of three percent with a variable torque load. For a given minimum slip and hydraulic coupling diameter, the hydraulic power transmitting capacity varies as the cube of the input speed. In using this chart, it is important that input horsepower be determined from the actual load horsepower. Many types of loads are over-motored and, in these cases, an incorrect coupling selection can result from using the motor rating. In addition, selections should be checked against the maximum mechanical ratings of the particular size, type and arrangement of fluid drive indicated.

In Fig. 3, one horsepower scale is used for *variable torque* selection and a different scale is used for *constant torque* selection. While it is impossible to classify all loads in one of two groups, most typical applications fall into one of these two catagories.

On machines such as fans, pressure blowers, centrifugal compressors and centrifugal pumps, the horsepower varies as the cube of the speed and the torque varies as the square of the speed. These would all be classified as variable torque loads. In reciprocating pumps, ball mills and similar machines, the horsepower varies directly as the speed and the torque is constant at all speeds.

The second step in the selection of a coupling is to determine the horsepower or torque characteristics of the load at reduced speed. With a variable torque load at 50 percent speed, the load horsepower is only one-eighth of the full-speed horsepower. Therefore, a comparatively small amount of oil is needed in the working circuit for operation under this condition. With a constant torque load at 50 percent speed, the load horsepower is one half of the full-speed horsepower. This would require a proportionately greater volume of oil in the working circuit. Taking this into account, the curves in Fig. 3 tend to indicate a smaller size for constant torque than for variable torque at the same horsepower and speed.

The third step is to determine the type of load. The general category of "variable torque loads" can be broken down into loads where the torque varies directly as speed, where the torque varies as the square of the speed, etc. The general category of "constant torque loads" can be divided into three classifications:

Load 1. Pure constant torque with calenders, paper slitters, reciprocating pumps and compressors, and textile spinning frames. With proper coupling selections, all of these run smoothly and can be controlled over a wide range of speeds.

Load 2. Constant torque loads with low momentum or loads subject to torque fluctuations caused by friction changes. Vacuum filters, hammermills, rubber forcing machines and ball mills fall in this class. These loads offer special problems in control because of the inherent instability of the load itself.

Load 3. Loads with special characteristics that cannot be included in either of the above two classifications. Acceleration drives, test rigs for rotating machinery, and winding and coiling drives fit this classification. As special considerations are involved,

Table I—Data Used in Selecting a Coupling for a Variable Speed Fan Drive

Fan speed, rpm	Fan brake horsepower	Percent speed	Coupling efficiency, %	Motor horsepower	Heat load horsepower
1,120	93.1	95.7	94.2	99.0	5.9
1,000	66.6	85.5	84.0	79.4	12.8
850	40.8	72.6	71.1	57.4	16.6
760	29.1	65.0	63.5	45.8	16.7
500	8.3	42.7	41.2	20.2	11.9
300	1.8	25.6	24.1	7.5	5.7

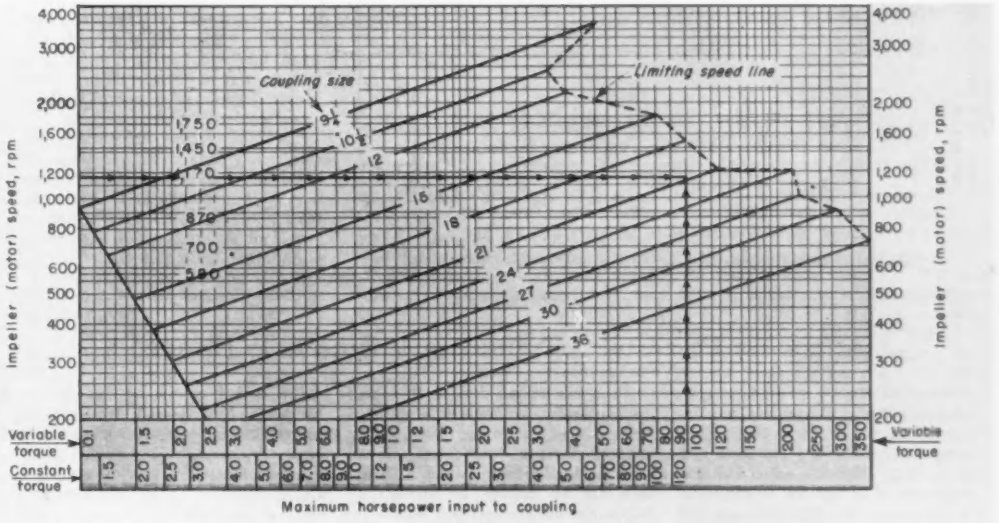

Fig. 3—Scoop-Control Coupling Selection Chart. Curves for each size coupling are based on selections having a minimum slip of three per cent with a variable torque load. Input power is determined from actual load power.

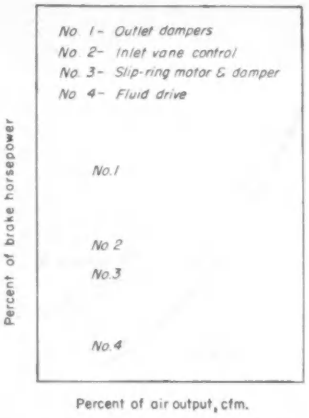

Fig. 4—Comparison of efficiency for different types of fan control devices.

each drive should be separately engineered rather than grouped into a general selection classification.

The fourth important selection factor is the maximum speed reduction required. As indicated above, there are limitations on the maximum obtainable speed reduction depending on type of load and the horsepower characteristics. When it is desirable to have a speed reduction that does not exceed the maximum limits set by the above considerations, this specific reduction should be used to figure the heat load for the oil cooler.

Typical figures used in the selection of a coupling for a variable speed fan are shown in Table I. The maximum motor horsepower listed is 99 and the maximum speed is 1,120 rpm. A 100-hp motor rated at 1,170 rpm will do the job. The brake horsepower varies as the cube of the speed, so this is a variable torque load. On the selection chart, Fig. 3, the intersection of the 1,170 rpm and the 100 hp lines for variable torque falls between coupling sizes 18 and 21. The larger coupling is therefore selected.

The fan speed, fan brake horsepower and percent speed (Table I) are the basis for figuring the motor horsepower and heat load horsepower. The motor horsepower is the fan horsepower divided by the coupling efficiency, and the heat load is the difference between the motor horsepower and the fan horsepower. The efficiency at reduced speed might appear to be low. However, it should be remembered that at 50 percent speed, for example, the horsepower is only one-eighth of full load horsepower and therefore this reduced efficiency acts on a very reduced horsepower. Actually a variable speed drive is the most efficient means of regulating the output of a fan. As illustrated in Fig. 4, outlet dampers, inlet vanes and slip ring motors in combination with dampers require more horsepower throughout the operating range.

The maximum heat load is the basis for oil cooler selection. The figures in Table I indicate that the maximum heat load occurs at 65 percent speed and amounts to about 17 percent of the full speed motor horsepower. To allow for errors in static pressure in the fan system, a heat load equal to 20 percent of motor horsepower is usually used as a basis for the cooler selection on variable torque loads.

The heat load characteristics of variable torque and constant torque loads are shown in Fig. 5. For a constant torque load, it is seen that the heat load is directly proportional to the speed reduction. At 75 percent speed, the heat load would be 25 percent of the motor horsepower; at 50 percent speed, it would be 50 percent. Therefore, the maximum desired speed reduction is the important factor in selecting the oil cooler for constant torque applications.

For either constant or variable torque, tabulated cooler selections are available. These standard selections are based on using 85 F water, a maximum oil temperature of 180 F and a maximum oil pressure drop through the cooler of 10 psi. The selection for the variable torque fan application above would be a shell and tube type oil cooler with a tube bundle 14 in. long and 5 in. in diameter, and with 9 sq ft of surface. While water is usually used as the cooling medium, air-oil coolers are also available.

The basic factors influencing variable speed fluid drive selections are based on load characteristics rather than on the motor or fluid drive itself. An analysis of all these factors is necessary if all requirements of a given application are to be met.

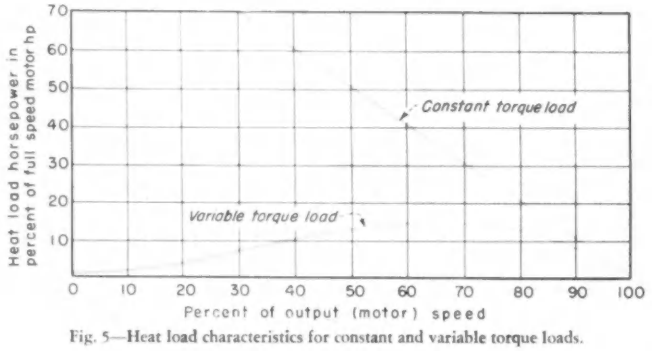

Fig. 5—Heat load characteristics for constant and variable torque loads.

Attack on Post-College Slump of Engineers Is Planned

DEVELOPMENT OF A positive program for combating "post college slump" in engineering was urged by H. P. Hammond, Dean Emeritus, Pa. State College, State College, Pa., to the Engineers' Council for Professional Development, at its recent annual meeting in Boston, Massachusetts. The Engineers' Council for Professional Development is a conference of seven engineering bodies representing 130,000 engineers and is located in N. Y.

Dean Hammond defined the "post college slump" as the period when a college graduate in his first job, no longer has the compulsion toward mental development because of the difficulty of making adjustments to conditions of employment which do not indicate the need for continuing personal development.

The speaker was part of a panel discussing a training program introduced last year by E.C.P.D. as a means to helping junior engineers to overcome this natural tendency to slough off in personal development after graduation. The council plans to spend $20,000 a year on a nationwide program of interesting local sections of engineering societies in developing self-help programs in six areas of-in-service training, continued college education; community service, professional registration, self appraisal, and selected reading.

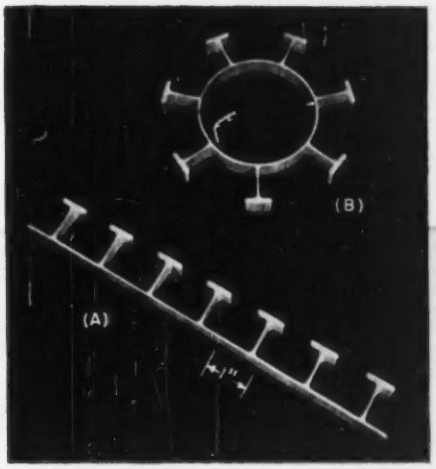

Fig. 1—Integrally reinforced aluminum panel (*A*) is illustrative of the structures on which test were run to determine mechanical properties. These panels were obtained by slitting and flattening extruded tubular sections, (*B*).

Mechanical Properties of Integrally Stiffened Aluminum Extrusions

Materials properties, including values for skin and flanges, of integrally stiffened 24S and 75S aluminum alloy extrusions. Test results on behavior of tubular and flattened sections under column and bending loads. General comparison of data with design values.

ROBERTO CONTINI
Structures Research
Lockheed Aircraft Corporation

ALUMINUM SHEET, extruded with *T* shaped stiffeners as an integral part of the section, is a relatively new type of construction. Present and potential applications extend not only to aircraft structures but to many other fields as well.

It is readily apparent that entirely different methods of production are required to efficiently handle such extrusions. But perhaps of greater importance is the accumulation of design data that will aid in their more efficient utilization. Toward this end, the structures research group of Lockheed Aircraft conducted tests to determine tension, compression, and elongation values of various alloys, heat-treats, and cross sections, and to compare them with design values; column and bending tests were also performed.

All test data were obtained from six extruded integrally stiffened panels manufactured by the Reynolds Metals Company. These panels were extruded as tubular sections, then slit lengthwise and flattened; Fig. 1 illustrates the two stages.

The salient features of the panels used in the tests are summarized in Table I. Panels 1 to 3 were reasonably flat without rough spots or kinks. The panels were essentially straight in the direction of the stiffeners, but some residual curvature existed across the width. Surface flaws like scuff marks and blisters were apparent particularly on the surface opposite the stiffeners: by reason of these flaws the material was not considered by the manufacturer to be of commercial quality. In addition, irregularities in the shape of the cross-section of the stiffeners were noticeable, Fig. 2.

Attempts were made to estimate the magnitude of residual stresses existing in the extrusions by sawing along various planes, thus freeing individual cross-section elements from each other, and observing any resultant bending deformations. Indications were that residual stresses, if any, were not important, with the exception, perhaps, of the flanges of the outermost stiffeners which appeared to be in compression on the side toward the edge of the panel and in tension on the other. These stresses may have been caused by localized forces applied during the straightening operations and may conceivably affect adversely the lateral stability of the flanges. The observations made, however, were strictly qualitative and not quantitative.

The fourth panel, which was flat-

tended by transverse stretcher-levelling was fairly flat in its entirety. However, when lengthwise strips, approximately 6 in. wide and including three stiffeners, were cut to obtain bending specimens, considerable lengthwise bowing toward the stiffeners resulted, Fig. 3. This bowing is believed to be the result of contraction of the skin, due to the Poisson's ratio effect in the direction of the length, i.e., normal to the stretching; as such contraction would be limited to the skins and would not extend to the flanges, bowing in the direction observed may reasonably be expected. The flattening operation appeared to have caused non-uniform stretching of the skin, since the measured stiffener spacing varied from about 2.00 in. to 2.12 inches.

Panel No. 6, had as a whole, a better appearance than Nos. 1, 2 and 3. However, shear buckles, which presumably had occurred during the flattening operation were visible in several of the thin stiffener webs.

Thus it is apparent that draw-bench flattening in some cases, produced local distortions of the stiffener webs; in general, the panels were reasonably flat, essentially straight lengthwise, with some residual curvature in the transverse direction (i.e., perpendicular to the stiffeners). This residual curvature does not appear to be serious as only bending of the skin is involved and the panels can be readily sprung flat elastically.

Transverse stretcher-levelling, on the other hand, produced considerable lengthwise bowing and further flattening operations would be advisable for actual application of sections of any appreciable length. Furthermore, it is difficult to obtain a uniform stretching throughout the panel, and cross-grain elongation appears to be adversely affected, as discussed later.

Table I—Condition of Integrally Stiffened Test Panels

Panel No.	Cross-Section Desig.	Alloy	Condition as Received from Manufacturer		Rework and Heat Treatment	Flat Dimensions, in.	
			Temper	Shape		Length	Width
1, 2, 3	SK-501	24S	24S-T4	Reasonably flat. Straightened by draw-bench operation	Except for one 4-ft. length of panel 2, aged to 24S-T8 condition	96	13.6
4	SK-562	75S	75S-O	Tubular, as extruded	Slit lengthwise, solution heat treated to 75S-W, flattened by stretching perpendicular to stiffeners, and aged to 75S-T6	60	28
5	SK-562	75S	75S-O	Tubular, as extruded	Coupon strips from tubular section flattened by hand without stretching, aged to 75S-T6	24.5	28
6	SK-551	75S	75S-O	Flat straightened by draw-bench operation	Coupon strips aged to 75S-T6	24	13.6

Tension and Compression Tests

Tensile and compressive properties for 24S-T material were obtained from standard coupons for sheet material, tested in a universal testing machine; stress-strain characteristics were determined by means of automatic recorders. Results are given in Table II.

With 24S-T8 aluminum, cross grain coupons were obtained at random from panels that had already been tested as columns, some at stresses exceeding the proportional limit. It was believed, however, that the column loads, being applied in the grain direction, would not affect appreciably the cross grain properties. With grain specimens were obtained at specified locations.

Values of yield stresses, both tensile and compressive and of ultimate tensile stress are seen to be consistently satisfactory. Flange material shows consistently higher properties than skin material.

Elongation in the with-grain direction is, in general, satisfactory. In the cross-grain direction, few reliable measurements were obtained and these seem to indicate somewhat inferior characteristics than with-grain: one coupon which shows an elongation of only 2 percent, broke at the intersec-

Fig. 2—The cross sectional shape of stiffeners of most panels showed some irregularity. This panel was flattened by a draw bench operation.

Fig. 3—Bowing of lengthwise strips cut from 75S-78 panels indicated contraction of the skin due to Poisson's ratio effect. The flattening operation on these panels apparently causes non-uniform stretching of the skin.

Table II—Skin and Flange Properties of Extruded Reinforced Aluminum Sections

Panel No.	Material	Skin Material (With Grain)				Skin Material (Cross Grain)				Flange Material (With Grain)			
		Tension			Compression	Tension			Compression	Tension			Compression
		Yield Str., psi	Ult. Str., psi	Elong., % in 2.0 in.	Yield Str., psi	Yield Str., psi	Ult. Str., psi	Elong., % in 2.0 in.	Yield Str., psi	Yield Str., psi	Ult. Str., psi	Elong., % in 2.0 in.	Yield Str., psi
1	24S-T8	59,100	64,400	5.7	60,500	63,000	67,500	Failed Outside Gage Length	63,400	60,200	67,000	6.5	63,500
		60,000	64,500	6.0	59,700	63,300	67,200			64,900	70,500	6.5	65,200
		60,500	65,600	6.0	60,900					62,200	68,000	7.0	63,800
		61,300	65,800	6.0	60,500					63,900	70,500	6.7	65,700
	Avg.	60,200	65,100	5.9	60,400	63,100	67,300			62,800	69,000	6.7	64,500
2	24S-T8	62,900	67,200	6.5	62,000	61,700	66,100	3.5	62,400	63,900	69,200	7.5	65,100
		62,300	66,400	5.5	61,900	62,300	65,300	2.0	63,800	64,900	70,000	8.0	65,300
		63,000	67,000	6.0	62,900					65,500	70,400	7.5	65,300
		61,400	65,500	5.0	60,200					65,800	70,800	7.5	66,300
	Avg.	62,400	66,500	5.7	61,700	62,000	65,700	2.7	63,100	65,000	70,100	7.6	65,500
3	24S-T8	62,400	65,600	4.5	58,200	61,200	66,300	5.0	63,000	62,600	68,800	7.5	64,800
		61,000	64,600	4.0	61,200	60,600	65,400	4.5		63,100	68,700	7.5	65,000
	Avg.	61,700	65,100	4.2	59,700	60,900	65,800	4.7		62.8	68,700	7.5	64,900
Lockheed Min. Design Value		55,000	64,000	5	52,000	50,000	58,000		52,000	55,000	64,000	5	52,000
4	75S-T6	70,900	80,300	11.5	74,000	(Failed)	70,000	——	74,500	77,100	88,900	11.0	79,500
		69,800	79,100	11.0	74,000	(Failed)	67,500	——	72,800	76,500	87,000	11.0	80,000
		70,800	79,600	10.5	74,400	(Failed)	69,200	——	76,400	77,000	87,200	13.0	78,400
	Avg.	70,500	79,700	11.0	74,100		68,900		74,600	76,900	87,700	11.7	79,300
Min. Guaranteed Values		70,000	78,000		70,000	58,000	66,000		70,000	70,000	78,000		70,000
Probability Design Values		76,000	83,000		76,000	61,000	69,000		76,000	76,000	83,000		76,000

Panel No.	Skin Material (With Grain)*				Skin Material (Cross Grain)**								Flange Material (With Grain)		
	Material	Yield Str., psi	Ult. Str., psi	Elong. % in 2.0 in.	Gage Length Location	Failure Location	Yield Str., psi		Ult. Str., psi		Elongation, % in 2.0 in.		Yield Str., psi	Ult. Str., psi	Elong. % in 2.0 in.
5		71,000	81,700	12.0	Between web Intersec.	Within Gage Length	75,000		83,500		11.0		80,600	90,300	11.5
		71,900	81,200	12.0			72,700		81,400		11.0		79,200	88,500	10.5
							72,800		81,900		10.0				
	75S-T6				Across web Intersec.	On or near Intersec.		70,900		76,500		2.5			
								68,900		74,500		2.5			
	Avg.	71,400	81,400	12.0			73,500	69,900	82,300	75,500	10.7	2.5	79,900	89,400	11.0
6		74,700	83,600	7.0	Between web Intersec.	Within Gage Length	79,500		88,100		8.0		84,000	92,800	10.0
		75,600	82,200	5.0			79,400		87,500		10.0		84,500	93,200	10.5
							79,200		87,800		8.0				
							73,500		80,900		10.0				
	75S-T6				Across web Intersec.	Near Intersec.		81,400		87,500		8.5			
						Away from Intersec.		75,600		82,000		5.5			
								78,100		83,200		5.5			
	Avg.	75,100	82,900	6.0			77,900	78,400	86,100	84,200	9.0	6.5	84,200	93,000	10.2
Min. Guaranteed Values		70,000	78,000				58,000		66,000				70,000	78,000	
Probability Design Values		76,000	83,000				61,000		69,000				76,000	83,000	

* 2 in. Gage Length Coupons

** 1 in. Gage Length Coupons

Table III—Column Strength of 24S Extruded Panels

Panel No.	Temper	Weight, lb.	Area[2] sq. in.	Length, in.	L/ρ[3]	Ult. Load, lb.	Ult. Stress, psi	Type of Failure
1	24S-T4	31.28	3.26	95.94	152.8	47,200	14,500	Column Failure
1	24S-T8	27.45	3.25	84.38	134.4	73,150	22,500	Twisting Failure
1	24S-T8	23.59	3.26	72.44	115.4	93,750	28,800	Column Failure
1	24S-T8	19.48	3.25	60.00	95.5	129,000	39,700	Twisting Failure
3	24S-T8	15.68	3.26	48.06	76.5	153,500	47,100	Column Failure
2	24S-T4	15.77	3.29	48.00	76.4	113,500	34,500	Lateral Instability of Flanges and Column Failure
3	24S-T8	11.78	3.27	36.00	57.3	175,000	53,500	Lateral Instability of Flanges and Column Failure
2	24S-T8	7.84	3.27	24.00	38.2	193,000	59,000	Skin Buckling Followed by Column Failure
1	24S-T8	3.94	3.26	12.08	19.2	198,000	60,700	Skin Buckling and Lateral Bowing of Flanges

1—Reynolds Cross Section SK-501; full width (13.6 in.) panels. 3—ρ = 0.628 in. (calculated)
2—By weight (.100 lb./in^3)

Table IV—Bending Test Results on Reinforced Extruded Aluminum Specimens

Panel No.	Material	Test Condition	Sect. Modulus S, in.[3]	Ultimate Load W, lb. (see sketch)	Ultimate Moment M, in. lb.	Ultimate Comp. Stress, M/S, psi	Type of Failure
1	24S-T8	Skin in Tension	0.820[1]	7,050	47,600[3]	58,000[1]	Lateral Instability of Flanges
2		Skin in Compression	0.801[2]	7,530	50,800[4]	63,400[2]	Skin Buckling
3	75S-T6	Skin in Tension	0.454[1]	4,700	31,700[3]	69,700[1]	Lateral Instability of Flanges
4		Skin in Compression	0.774[2]	5,800	41,800[4]	54,200[2]	Undetermined

1—At centerline of stiffener flange 2—At centerline of skin 3—M = WL/8 (L = 54 in.) 4—M = 1.07 (WL/8)

tion of the skin with the web; all others broke elsewhere.

In the case of 75S-T6 material flattened by stretching (panel No. 4), stress values for the skin were slightly higher than design values based on minimum guaranteed properties but lower than those based on probability. Stress values for the flange material and all with-grain elongation values are consistently satisfactory in all respects. In Table II, cross-grain values of tensile yield are omitted, the reason being that the coupons failed before reaching yield. It was suspected that failure might have occurred where, in the original cross section, the stiffener web intersected the skin. As the coupons were machined smooth, this could not be determined visually; therefore, recourse was made to metallographic analysis which confirmed such suspicion in all cases. The fractured surfaces were extremely fibrous in character, as contrasted with the usual smooth-surfaced shear planes.

As the cross-grain coupons did not reach yield, the elongation was less than 0.2 percent. By comparison Panels Nos. 1, 2 and 3 of 24S alloy, where the same geometry existed, showed a much higher elongation and, as a rule, did not fail at the intersection point between web and skin. Panel No. 4 was flattened by transverse stretcher-levelling, and, as previously noted, the irregular stiffener spacing appears to indicate excessive localized stretching which may be conductive to early tensile failure. In order to clarify this point, material property tests for the two succeeding panels were undertaken.

The following observations can be made on these two panels:

1. Panel No. 6 (flattened by drawbench process) had slightly superior properties than Panel No. 5 (hand-flattened without stretching) as far as strength values are concerned.

2. With-grain strength values for skin material met minimum design requirements but not those based on probability. Cross-grain values were satisfactory in both respects.

3. With-grain elongation values for skin material were slightly higher for Panel No. 5 (hand-straightened) than for Panel No. 6 (draw-bench flattened). The same was true for cross-grain elongation whenever the gage length was confined between successive web intersections. In those cases where, on the other hand, the gage length ran across a web intersection, elongation for Panel No. 5 dropped to low values and failure occurred near or on the intersection. As for Panel No. 6, loss of ductility in such cases was much smaller and in no case did failure occur on the intersection.

4. Flange material showed good elongation, and strength values higher than design values based on probability.

Column Tests

Seven column tests were made on lengths from one to seven feet in one-foot intervals obtained from panels of 24S alloy in the aged (24S-T8) condition. In addition, one eight-foot length and one four-foot length were tested in the unaged (24S-T4) condition.

Specimen ends were machined square and parallel. The specimens were tested between flat platens in a 400,000 lb. universal testing machine. Centering was done under load by trial and error, until the upper-head travel, measured by four dial gages placed one at each corner of the plat-

en, was determined to be substantially uniform. As a further control on the accuracy of loading, lateral deflections were measured at the center except for the one-foot length specimen.

To minimize the effect of the transverse curvature that most of the specimens exhibited, wooden clamps were placed on the specimens at convenient intervals. For the shorter specimens the clamps were removed after some load was applied, as the friction at the ends was sufficient to hold the panels flat.

Results are summarized in Table III and plotted in the form of failure stress versus slenderness ratio, Fig. 4. Calculated column curves for various values of the end-fixity coefficient "c" are also shown. These curves are based on the tangent modulus, the latter being calculated on the assumption that the stress-strain curve is representable by means of the Ramberg-Osgood relationship (ref. 3). The three parameters required, i.e., the shape factor "*n*", the Young's Modulus *E*, and the 70 percent secant yield stress F_{07} were chosen respectively as 20 (a suitable value for aged 24S extrusion), 10.7 x 10^6 psi (from ANC-5) and 60,900 psi, the latter value being an average obtained for skin material.

The values of the end-fixity coefficient to which the test points correspond with respect to the calculated column curves fall within the range 3.0 to 4.0 approximately, with the exception of the four-foot length of unaged material for which the column curves do not apply. The eight-foot length was also tested in the unaged condition, but, as failure occurred well within the elastic range, its strength would not be affected by aging. Such values of the end-fixity coefficient are typical for tests of this type, thus showing that conventional column analysis may be applied to integrally stiffened extrusion as should be expected. The good agreement between test points and calculated curves extends also into the short range where failure occurred by skin buckling or lateral instability of the stiffener flanges (sometimes either accompanied or followed by column failure); this would indicate that, for the particular cross section tested, failures of the "crippling" type are not critical in the sense that they occur at stresses at which column failure is about to occur anyway.

A curious type of failure was observed in two of the long-column specimens, namely: the five-foot and the seven-foot lengths. These specimens, instead of bowing all in one direction, as columns usually do, failed into a twisted pattern; one edge bowed toward the skin and the other toward the stiffeners. Evidently the dimensions of the test sections were such as to make them equally critical under a torsional mode; however, test values for these specimens are not inconsistent with those of other specimens, which failed in the usual manner.

Bending Tests

For bending tests, two specimens were cut lengthwise from the five-foot length from panel No. 1 previously used for a column test, and two similar specimens from panel No. 4. All these specimens consisted of three stiffener units.

Two specimens were tested with skin in tension and two with skin in compression on a 54 in. span with concentrated loads at quarter points. The load was increased gradually up to ultimate.

Deflections for specimens 24S-T8 panels were measured by means of dial gages; these measurements proved ineffectual inasmuch as the dial gage travel could cover only the first stages of the tests. For 75S-T6 panels the travel of the cross-head of the testing machine was measured by means of a steel scale. In this manner an approximate measurement of the total deflection at failure was obtained.

Because of the rather large deflections involved, it might be expected that some correction to the elementary formula for the bending moment $M = WL/8$ would be necessary as a result of horizontal components of loads and reactions. This correction, however, as calculated from deflection data, was found to be small—of the order of 2 percent—for all cases except for 75S-T6 in compression for which the overall deflection was particularly high because the initial bowing (approximately 1 in.) was in the same direction as the applied bending deflection. The necessary correction for this specimen was determined to be approximately 7 percent.

Test results are summarized in Table IV. Both specimens with skin in tension failed by lateral instability of the stiffener flanges, the calculated stress in the flanges being approximately 90 percent of their yield stress. For 24S-T8 with the skin in tension the failure stress is comparable to that of a column as long as the free length of the stiffener flanges of the bending specimen (27 in.).

The panel of 24S-T8 with skin in compression, failed by skin buckling, the calculated stress in the skin being approximately 105 percent of its yield stress. The actual stress was probably somewhat lower due to some "modulus of rupture" effect.

The panel of 75S-T6, also with skin in compression, did not develop any type of instability but reached an ultimate load at a rather low skin stress.

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1. Reynolds Metals Co., "The Manufacturing Technique and Possible Uses of Extruded Integrally Stiffened Skin," Technical Conference held April 7, 1950.

2. "Integrally Stiffened Structures," Paul Sandorff and G. W. Papen, Aeronautical Engineering Review, Feb., 1950.

3. "Description of Stress-Strain Curves by Three Parameters," Walter Ramberg and William R. Osgood, NACA Technical Notes No. 902, July, 1943.

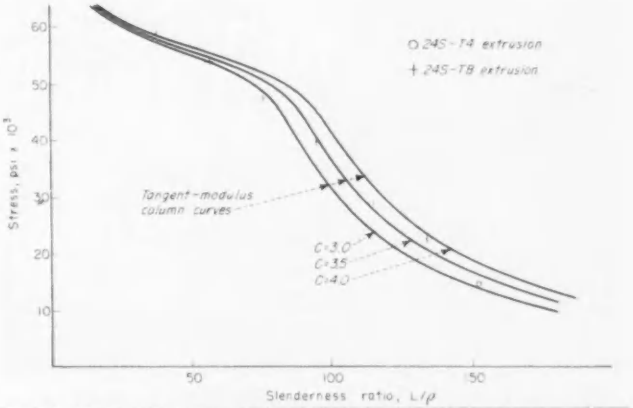
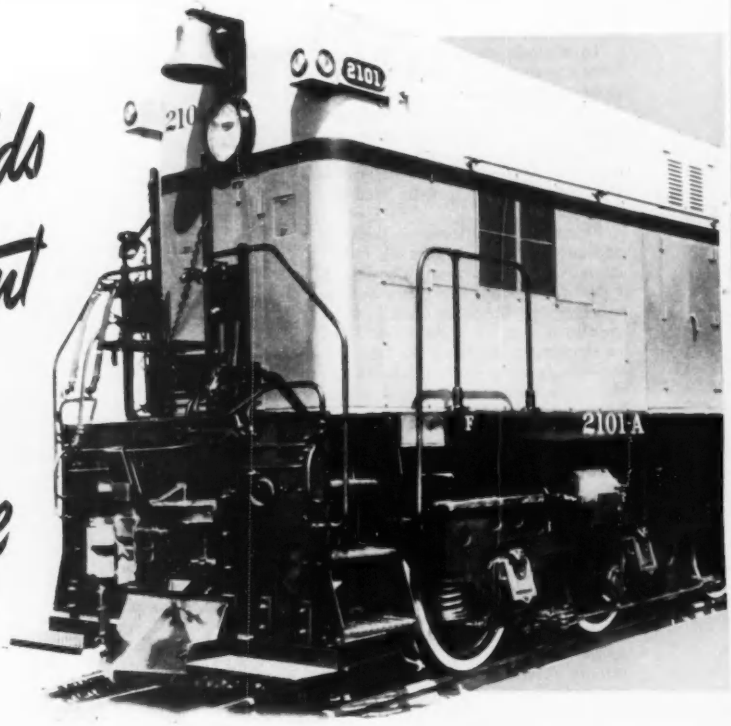
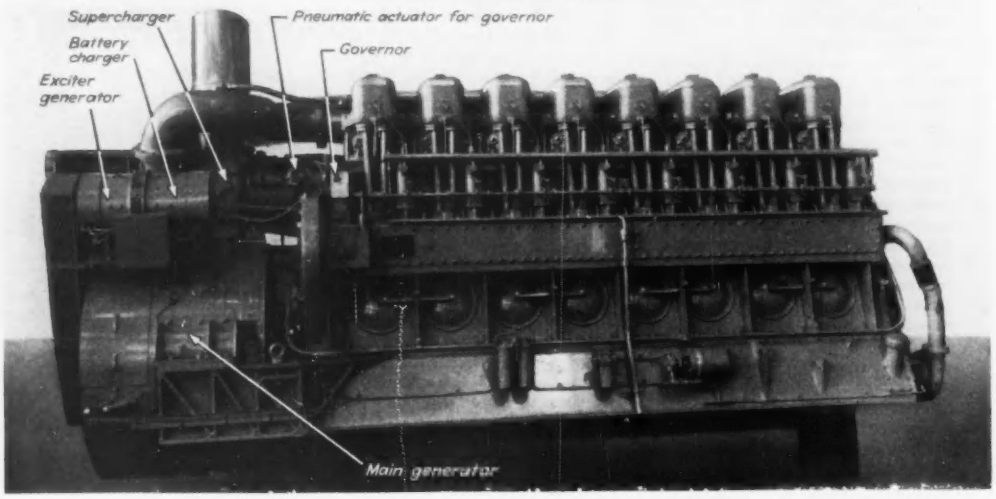


Fig. 4—Effect of slenderness ratio on load carrying ability of aluminum extrusions with integral stiffeners. Values for *C* represent the end-fixity coefficient. Data is for Reynolds SK-501 cross section, 24S-T8 aluminum alloy.

DESIGN FEATURES

Redesign Adds 23 Percent Pull to Locomotive





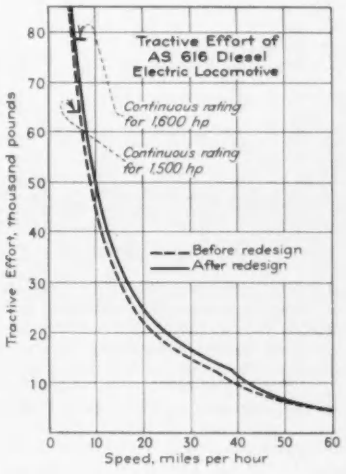
THE ALL-SERVICE MODEL AS-616 locomotive is a 1,600 hp diesel-electric unit equipped with a traction motor on each of its 6 axles. Normal axle loading is 54,167 lb, but where greater weight is needed ballast can be added up to 62,500 lb per axle. Driving power comes from a Model 608A, 8-cylinder, 625 rpm, 4-cycle supercharged solid-injection diesel engine capable of developing its rated output of 1,750 bhp up to 8,000 ft altitude. The generator is direct connected and the traction motor blowers (not shown), exciter and battery charger are V-belt driven.

IN NEW PRODUCTS

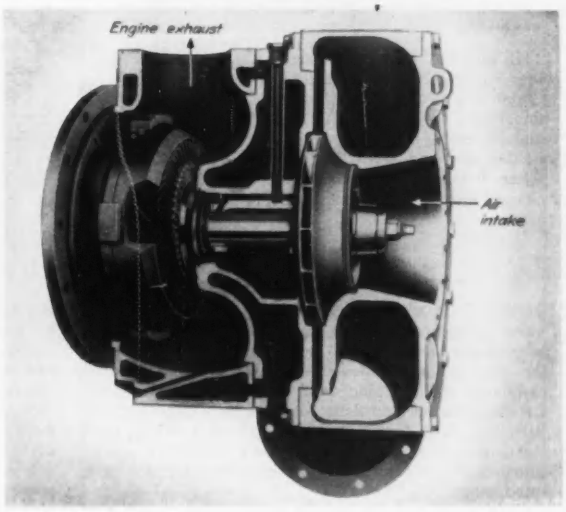
Refinements in design and structural changes in the Baldwin-Westinghouse AS-616 have increased its horsepower from 1,500 to 1,600 and made it a better all-service locomotive with 23 percent more continuous tractive effort. This 1,600 hp diesel-electric unit, the heaviest locomotive of its type in the field, is equipped with 6 traction motors to meet heavy-duty service where extremely high starting and running tractive efforts are required.

Increased performance of the locomotive was partly due to important design changes in the diesel engine. The new bedplate is a welded steel structure fitted with heavy cast-steel, transverse webs to support the main bearings. Crankshaft is larger at main and crank journals with larger radius fillets to reduce stress concentration. Crank webs are thicker and connecting rods are heavier in cross section. Main and crank bearings are thin precision copper-lead type, which permit installing the new crankshaft in older engines by a slight modification in machining.

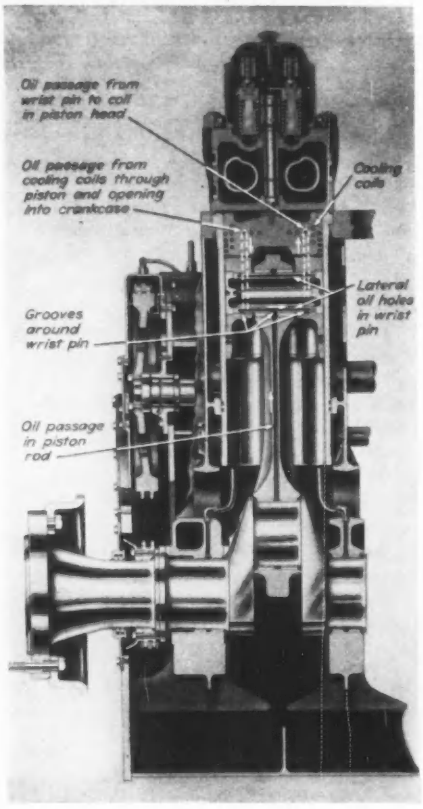
The electric transmission, with its fixed series-parallel motor connection, is a true torque converter. With this hook-up and the pneumatic trottle, engine torque is converted to axle torque in gradually and uniformly increasing amounts so that acceleration is fast and smooth right up to the adhesion limit. The AS-616 provides 2,400 hp of dynamic braking capacity with maximum braking at 15.7 mph.



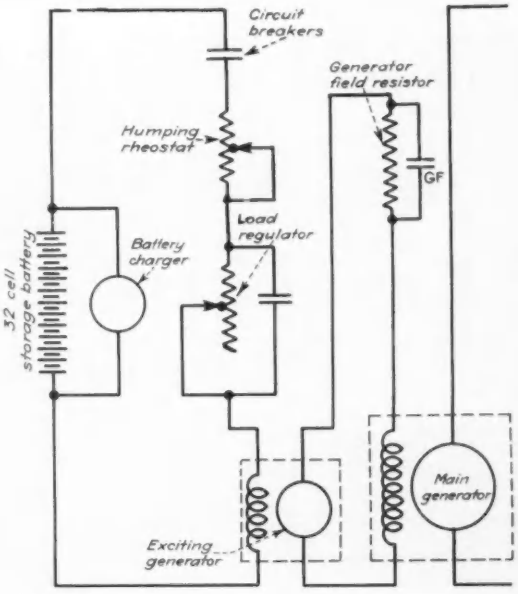
LOCOMOTIVE TRACTIVE effort curves show how the many improvements and changes in design add up to give greater horsepower output from the diesel and a 23 percent increase in locomotive continuous tractive effort.

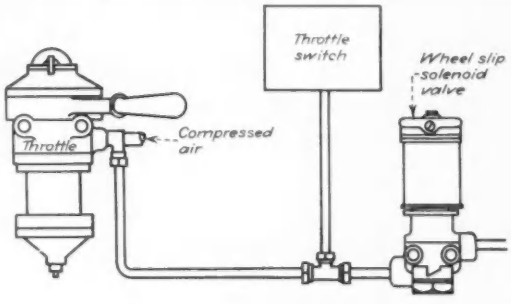


THE SUPERCHARGER now has a cast aluminum air inducer and a forged and machined impeller, able to withstand higher tip speeds. Changes in shaft and bearing design reduced the rotor's overall diameter. The supercharger will operate at the high speed and temperatures needed to hold full diesel rating up to an altitude of 8,000 feet.


Oil passage from wrist pin to coil in piston head
Oil passage from cooling coils through piston and opening into crankcase
Cooling coils
Lateral oil holes in wrist pin
Grooves around wrist pin
Oil passage in piston rod

THE DESIGN of the heat-treated alloy pistons has been changed to provide additional cooling of the piston crown. The new pistons incorporate additional steel cooling coils cast into the crown. Oil under pressure comes through the crankshaft, connecting rod and wrist pin to cooling-coil inlet. After flowing through the piston the oil is discharged directly from the coil outlet to the crankcase.





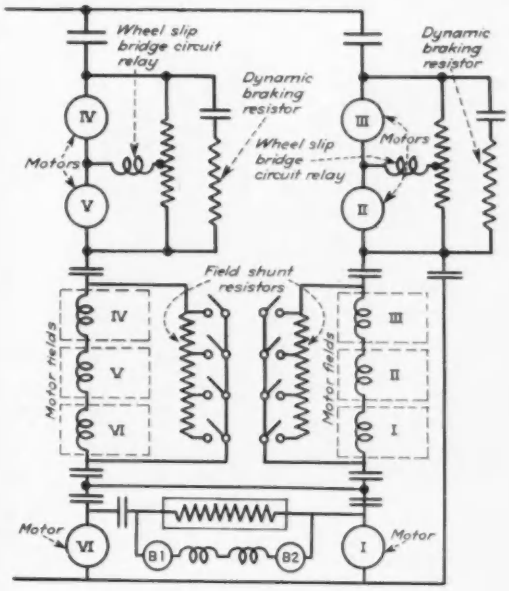
TORQUE CONVERSION: with this fixed series-parallel motor connection, engine torque is converted to axle torque in gradually and uniformly increasing amounts right up to the adhesion limit. Movement of the pneumatic throttle eases a change in engine speed to give smooth even acceleration as the load regulator increases main generator field strength. After engine speed and generator voltage reach maximum, traction motor field shunt contactors operate automatically to maintain full horsepower over the wide speed range.

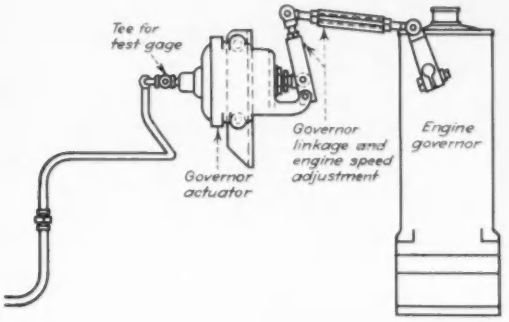
Field short circuit: when the unit is to be used in road service, where full horsepower output at higher speeds is desired, control circuits can be equipped to include series field short-circuiting contacts, which short circuit the field on one motor of each truck.

Humping rheostat: for humping service, a variable rheostat is connected in the generator exciter field circuit (upper left), and its setting determines the locomotive speed at the needed tractive effort. It has also found great favor in regular service for starting heavy trains. In humping, the diesel engine is run at full speed to assure plenty of cooling air for the traction motors, and the rheostat adjustment regulates the locomotive speed at the tractive effort desired.

Wheel slip: to control wheel slip, a relay coil is bridged across the midpoints of each pair of motor armatures and a parallel resistor. When both motors pull together, potential across the relay coil is zero, but if a set of wheels slip the motor's counter emf will increase, the bridge balance will be upset, and current flows through the relay coil.

Operation of the relay sounds a buzzer in cab, opens the



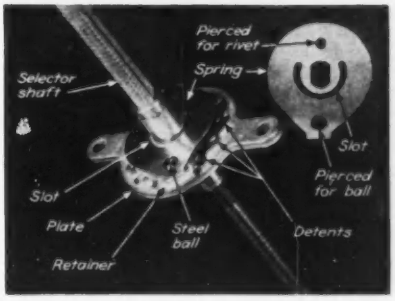


exciter field circuit, and actuates a solenoid valve in the pneumatic throttle line to engine governor to reduce the engine's speed until slipping stops. When this occurs bridge balance is restored, relay is de-energized and the air valve permits the engine speed to return to that corresponding to throttle position.

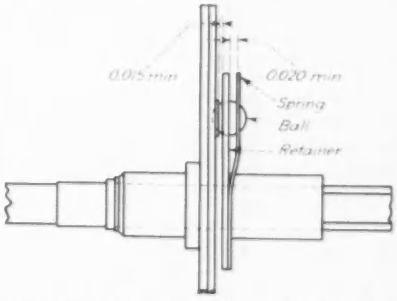
Dynamic braking: in dynamic braking, circuit breakers are actuated to connect braking resistors across the traction motor armatures and to connect the motor fields across the main generator. Then with the generator field resistor included in the field circuit to limit main generator field current, and an addition resistance inserted in exciter field circuit, dynamic braking is controlled by manipulating the throttle to vary diesel-engine speed and generator voltage. The heat generated in the braking resistors by the motors is dissipated by forced air from engine driven blowers.

Phosphor Bronze Replaces Steel for TV Selector Spring

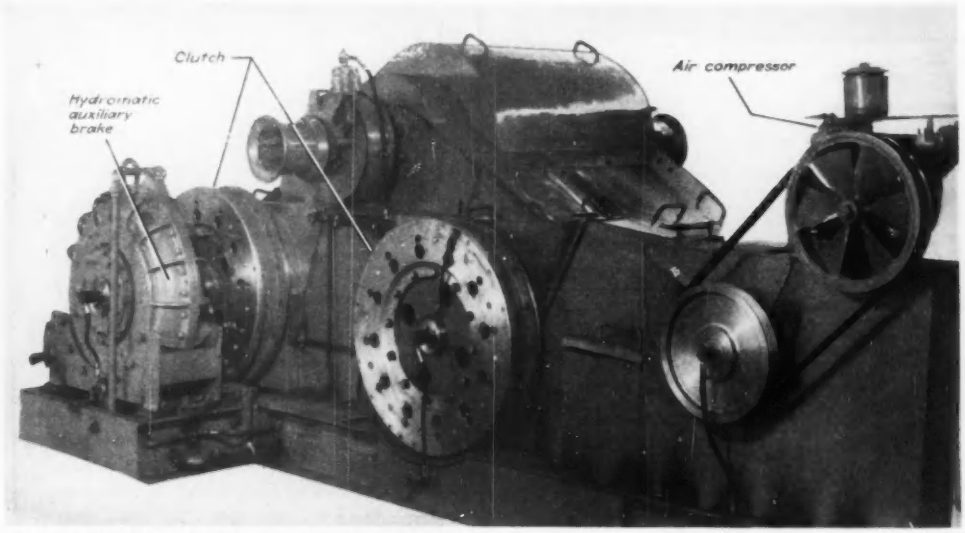
Phosphor bronze has replaced steel as material for the spring used to maintain pressure on the ball of a TV channel selector detent mechanism. The ball seats in one of a series of detents in a plate and stops the tuning knob at each of the 13 channels. The previous flat steel spring, rectangular in shape, failed in fatigue near the selector shaft axis, usually after a few months of service. The new design can withstand over a million deformations, which corresponds to about 8 years of continuous usage. It is a result of cooperative efforts of The Eastern Specialty Co. of Philadelphia and The Riverside Metal Co. of Riverside, N. J. It is used by several TV manufacturers.



REDESIGNED SPRING is approximately circular in shape and has a kidney-shaped slot to distribute the bending stresses. The phosphor bronze alloy was chozen on the basis of toughness, fatigue strength, low-coefficient of friction and ease of blanking, forming and finishing.



RETAINER holds the ball in a plane parallel to the track, spring holds it down. Pierced hole in retainer permits ball to turn freely. Spring is riveted to retainer and both are keyed to the selector shaft.

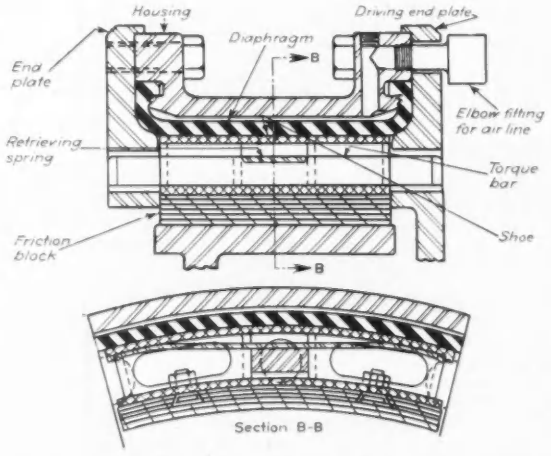


TYPE 50-A DRAW WORKS uses two of the new clutches. One is on the hoisting drum which is driven at three different high speeds. The other is on the master clutch shaft that is driven direct from the engine shafts by a triple roller chain. This rig is normally considered for drilling to depths of 5,000 to 6,000 ft. using 450 input horsepower. The speed of the hoisting drum is controlled by means of a pneumatically operated jaw clutch.

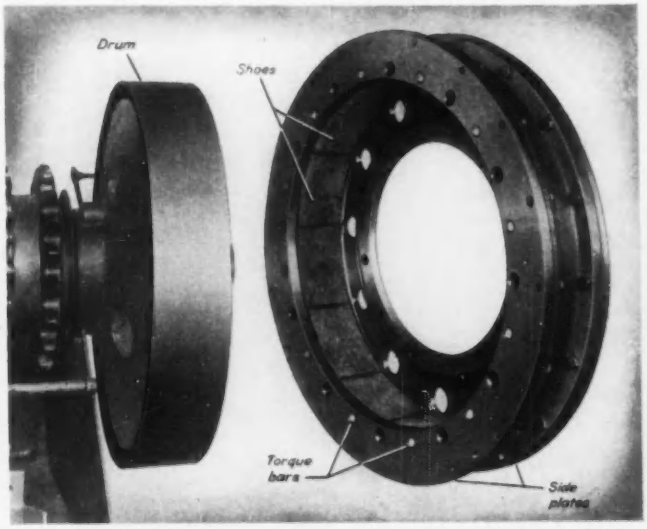
Oil Well Rigs Now Use Friction

Effortless clutch operation free from all manual adjustments is now obtained on oil well drilling machinery manufactured by the Torrance, Calif., plant of the National Supply Company by means of the Ideal Dy-A-Flex Clutch. This is a constricting type clutch in which the friction shoes are moved radially inward by air pressure acting on a cylindrical, rubber diaphragm. The amount of torque transmitted varies in accordance with the air pressure which is controlled by a regulating type valve.

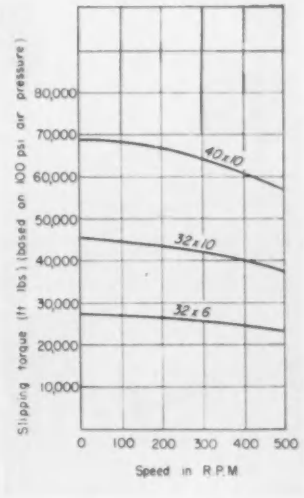
Although designed specifically for oil well equipment, the Dy-A-Flex can be adapted for other uses. The loads imposed by the oil rigs, while peculiar in some respects, are similar to those of many other industrial machines. Varying, heavy loads must be picked up smoothly and quickly, sometimes in one minute cycles. Since auxiliary cooling is not practical for oil field work, the clutch must run continuously in the released position without overheating.



FRICTION SHOE TORQUE which is controlled by regulating the air pressure is applied to the drum by the side plates by means of torque bars extending through the shoes. Torque bars have a loose fit in the end plates allowing sufficient radial movement to apply and completely disengage the shoes. Retrieving spring, aided by centrifugal force, supplies force for releasing the brake and maintaining a space between the shoes and drum to permit air circulation.

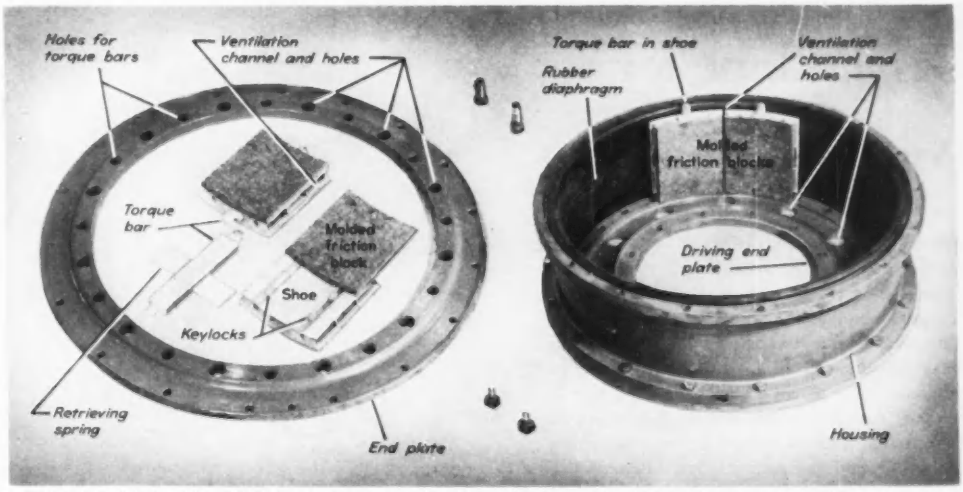


EACH FRICTION SHOE is a self-contained assembly that includes a friction block lining, torque bar and a retrieving spring. Principal elements are finish machined all over eliminating balancing and counter weights. Mounting of the friction shoe is simplified by using one of the side plates as an adaptor ring.

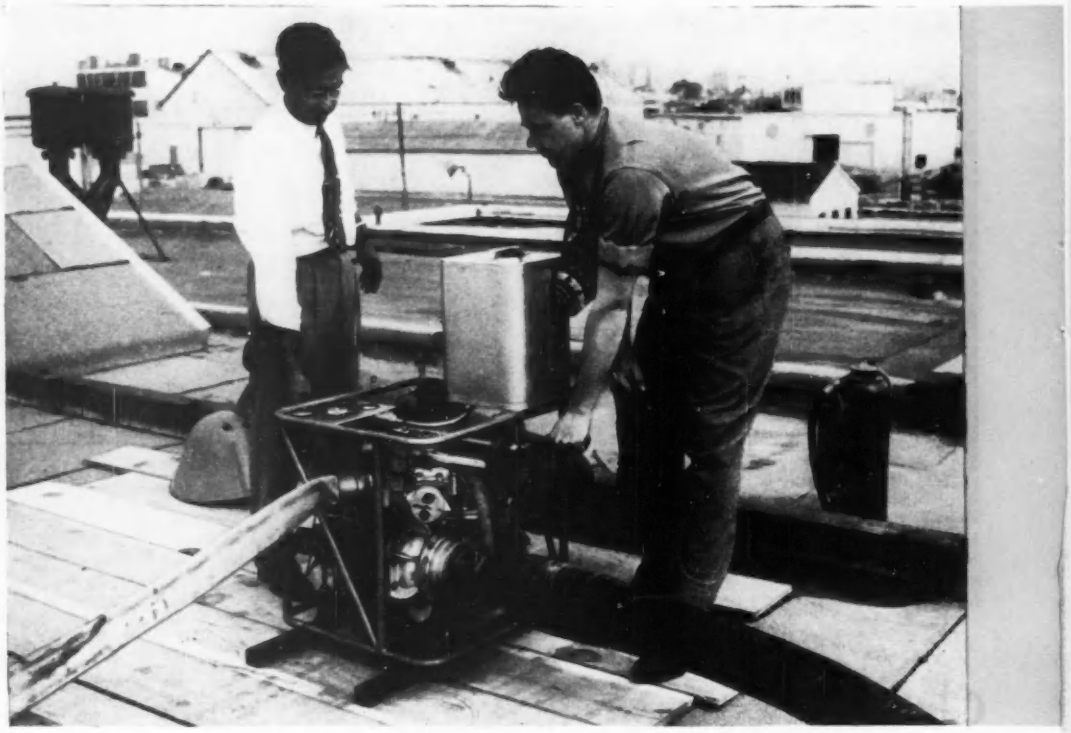


THREE SIZES now being used have torque characteristics as shown above. Two or more years of service may be anticipated without maintenance.

Clutches That Need No Adjustments



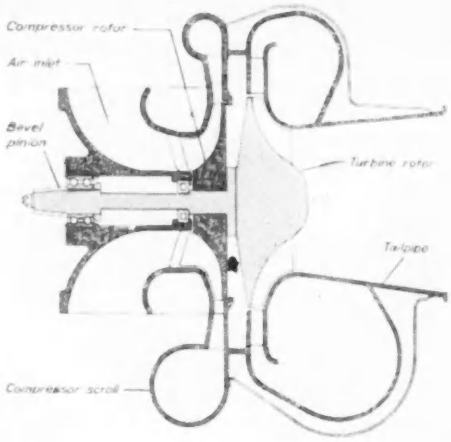
FRICTION SHOE ASSEMBLIES can be removed individually and linings replaced without disassembly. Passages within the shoes match openings in both side plates to provide induced air cooling and to insulate the diaphragm from the heat generated by friction block contact. The retrieving springs keep the blocks from riding on the brake drum. Diaphragm flanges are gripped by integral ridged rings in the housing to seal the high-pressure air chamber. Air space between the diaphragm and the brake housing is kept small in order to minimize the amount of flexing of the rubber and quicken clutch response to changes in air pressure. Compressed air required for the clutch is supplied by a compressor that is mounted on the hoist.



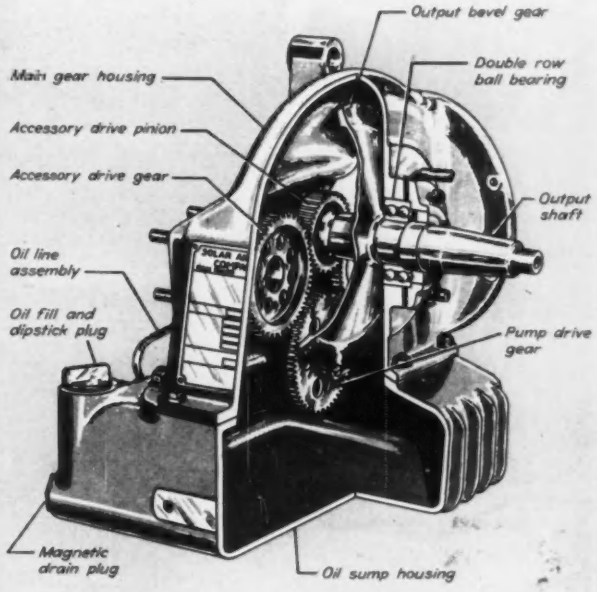
Gas Turbine for Portable Fire Pump

To reduce the size and weight of its portable fire pump, driven by a four cylinder, two cycle gasoline engine, the Navy Department requested proposals for a gas turbine powered unit. Basic ratings of the pump were unchanged; 500 gpm at 100 psig discharge pressure and 16 ft. suction lift. Other requirements were that the engine be hand started, use diesel fuel, have a waterproof ignition system that operated without battery or external power.

Solar Aircraft Company of San Diego, Calif., developed the unit shown, designated as Model T45, which uses the original pump with minor modifications. Its envelope dimensions are 26⅞ in. long; 23½ in. high; 23⅞ in. wide. Dry weight, less fuel and tanks, is 165 pounds. Power requirement at rated conditions is 47 horsepower.

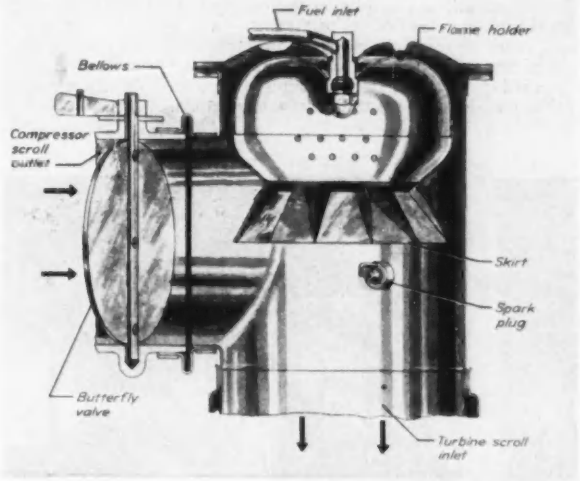


SEPARATE TURBINE and compressor rotors keep disk stresses low, restrict heat transfer to compressor and permit freedom in selecting materials and in component design. Blades of compressor and turbine rotors are shaped to form inducer and exducer, respectively. All engine bearings are anti-friction type. The maximum speed of the turbine is 40,300 rpm.

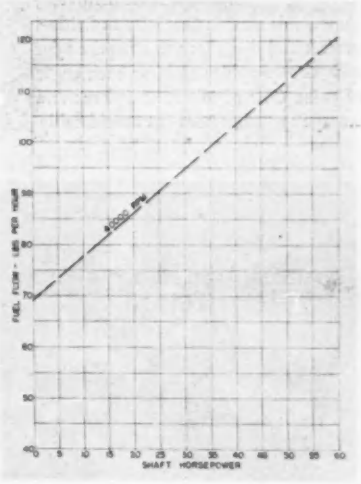


BECAUSE of limitations on compression ratio imposed by hand starting, compressor is single-stage, centrifugal type. Size effects, simplicity, and cost influenced this choice and dictated use of radial inflow turbine. Chain and sprocket arrangement provides an 81 to 1 speed increase for starting. When turbine speed exceeds crank input speed, over-running clutch on pump shaft disengages starting device.

SPIRAL bevel gear and pinion arrangement reduces the 40,300 rpm of turbine to the 4,428 rpm required at pump to maintain flow rate without cavitation. Turbine axis is perpendicular to the output shaft. Pump impeller is mounted on output shaft, eliminating need for pump bearings. Spur gears and a pinion on the output shaft drive the fuel pump, governor, oil pump and overspeed shut off valve.



COMBUSTION CHAMBER, located between compressor scroll outlet and turbine inlet is elbow-shaped to conserve space. Efficiency and pressure loss compare favorably with can-type burners. Butterfly valve in compressor outlet creates low velocity area during starting to facilitate ignition. An aircraft type spark plug located below skirt of combustion chamber starts the flame which is held inside the dome flame holder.

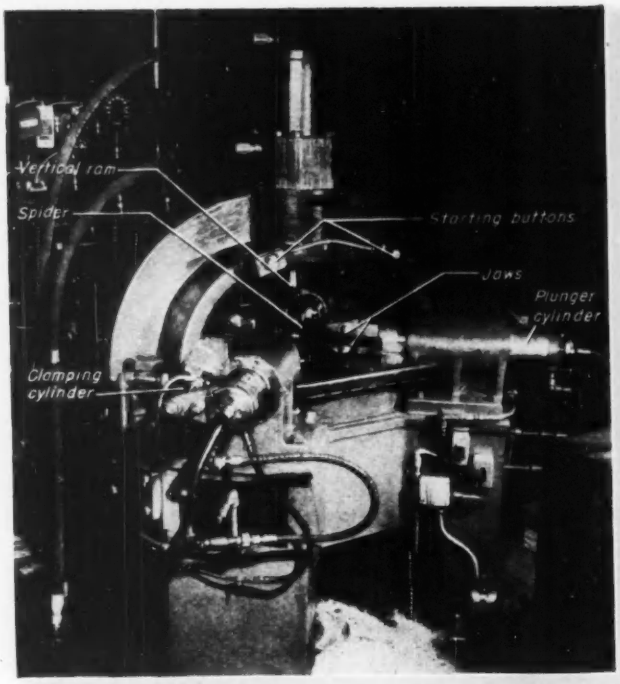


FUEL FLOW and shaft horsepower relationship in 80 F. ambient temperature is shown above. Specific fuel consumption is 2.22 lb/hp-hr for these conditions. Exhaust temperature is held to 300-400 F. by introducing water spray in exhaust nozzle.

Hydraulically Driven Twister Uses Special Face Gears

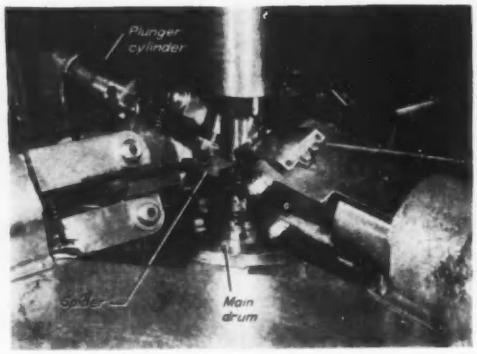
By driving the four gripping jaws from the face gear on the main drum, this hydraulically operated machine simultaneously twists the four elements of electric fan spiders within a tolerance of plus or minus ¦ degree. The angle of twist can be varied by means of adjusting bolts that contact a stop on the main drum, and from 300 to 600 spiders per hour, ranging in size from those for 8 in. dia fans to those for 30 in. fans, can be handled by replacing the interchangeable jaws.

Designed by the Torrington Manufacturing Company of Torrington, Conn., this machine replaces individual presses and dies that were required for each size of spider and for each angle of twist. Cost of labor, equipment and storage space has been cut considerably.

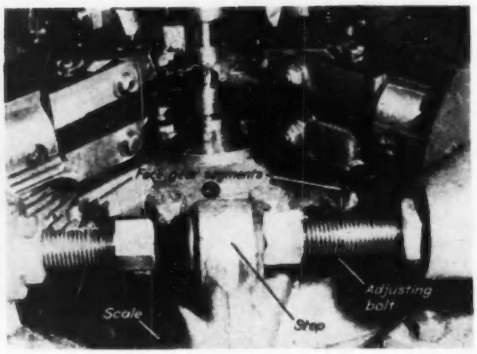


OPERATOR PLACES SPIDER on holder and lowers main ram to hold it in place. Jaws move radially inward and grip the spider blades. Twisting is accomplished by rotating the spider about a vertical axis and simultaneously rotating each of its blades about the horizontal centerlines of the jaws.

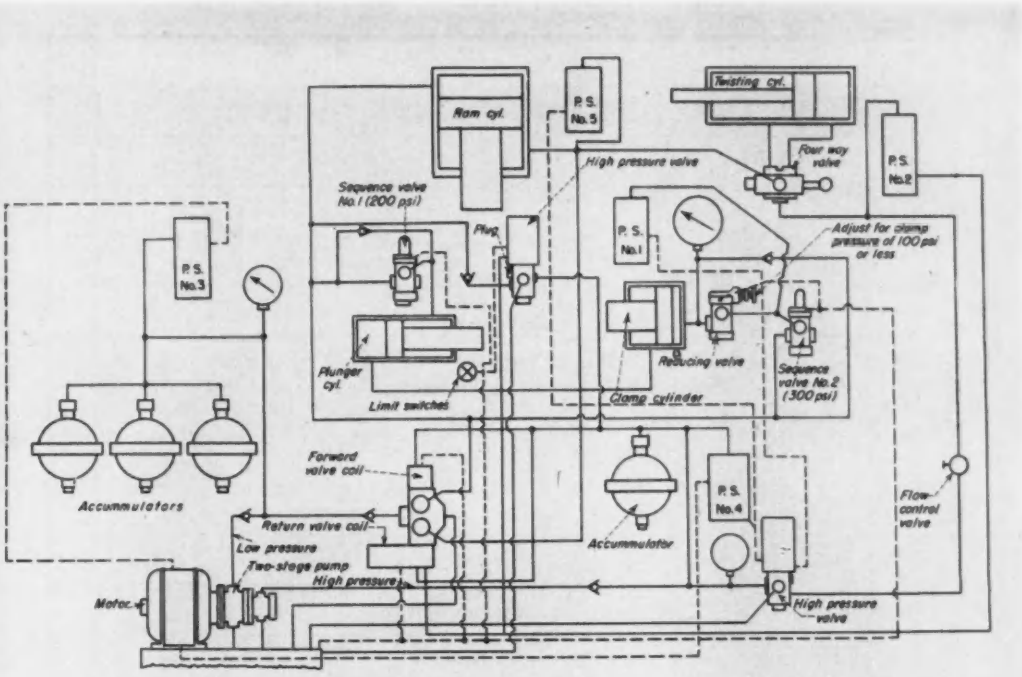
Pressure sensitive elements of hydraulic system distributes output of two-stage pump to control sequence of operations. Depressing starting buttons energizes forward-valve coil and permits low pressure oil to lower the vertical ram. When ram stroke is completed,



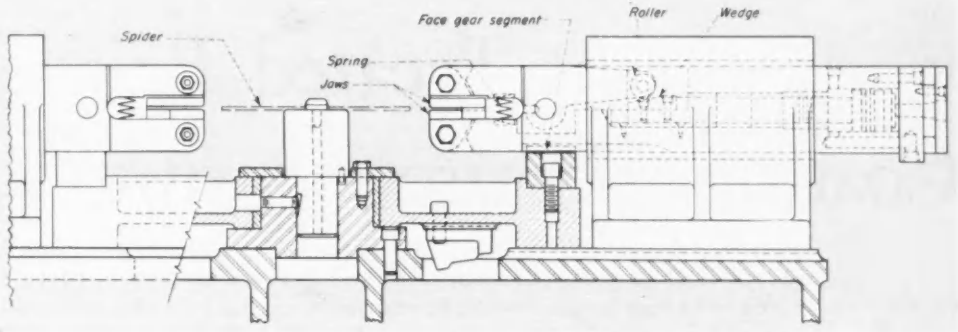
HYDRAULICALLY OPERATED main drum which rotates spider has face gear segments that mesh with teeth on plunger cylinder to rotate jaws. Three jaws are shown rotated; fourth has been blocked in place for illustration.



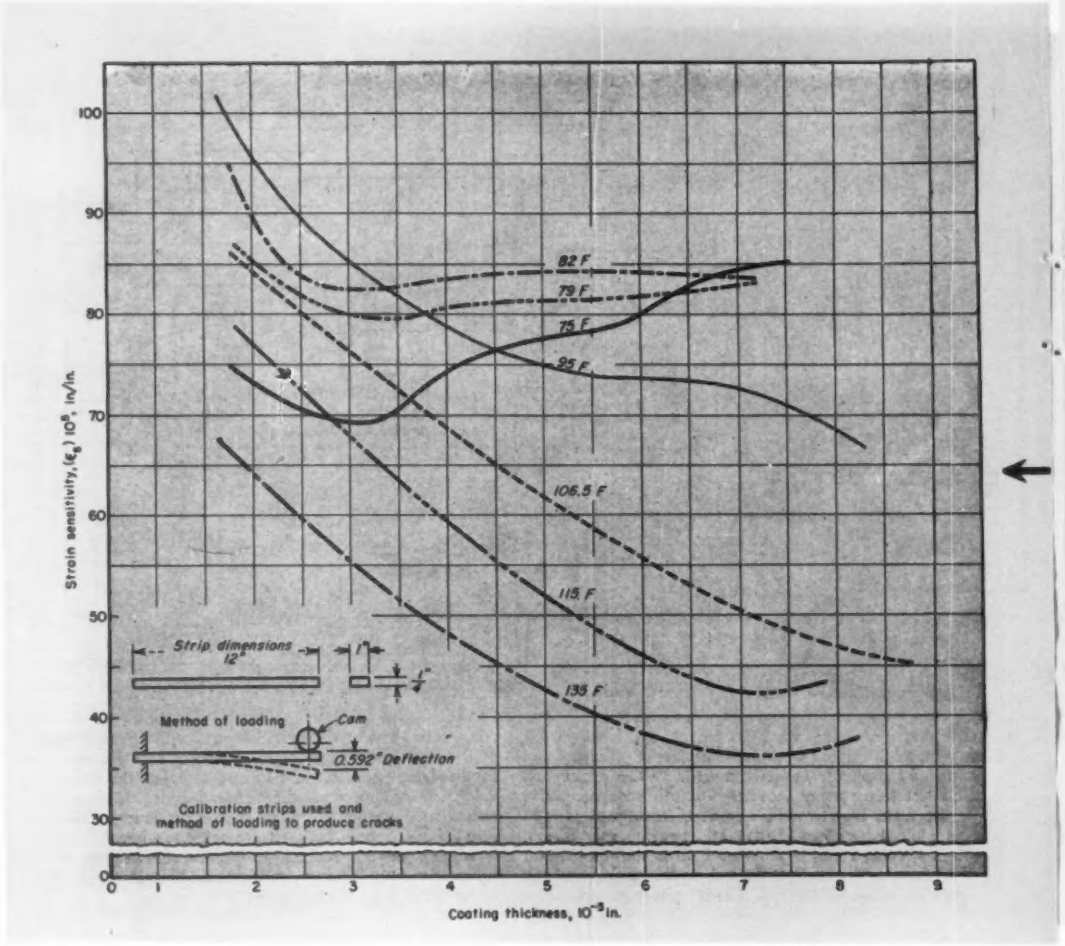
FACE GEAR TEETH are special form to permit jaws to move radially for gripping and to rotate during twisting. Adjusting bolts control the angle of twist by limiting the rotation of the main cylinder to angles preset on the scale.



pressure builds up. At 200 psi, sequence valve #1 opens, admitting oil to the four horizontal plungers and moving the plungers radialy inward. When pressure in low pressure system becomes 300 psi, sequence valve #2 actuates the clamping cylinders, causing the jaws to close on the spider. When all jaws are in position, limit switches admit high pressure oil to the vertical ram for stamping the company's seal on the spider. When pressure reaches 1,000 psi, PS #1 energizes the valve coil of the twisting cylinder that rotates the main drum of the machine. When pressure reaches 800 psi, twisting has been completed and PS #2 energizes the return-valve coil. This vents the forward cycle system and returns all elements, except the twisting cylinder, to their original positions. Jaws release spider and move outward but are not rotated, to prevent untwisting the spider. Pressure in return builds up and returns twisting cylinder and jaws to normal.



DETAILS OF JAWS for spiders of 24 in. dia fans are shown above. Hydraulically driven wedge pivots upper jaw for closing action. Spring force keeps jaws open when wedge is retracted. Jaws are readily interchangeable as units to accommodate the different sizes of spiders and clamping pressures can be adjusted manually. Face gear segments were cut from a continuous ring. The interchangeable parts not in service can serve as replacements.



Heat Treated Brittle Coating Increases Sensitivity

Results from a five year research program show that the sensitivity of brittle coatings can be materially increased by heat-treatment, thus making them more adaptable for analysis of low-stressed areas.

Fig. 1—Strain sensitivity of Coating 1205 as a function of coating thickness and curing temperature. These are smoothed curves, based on data obtained from prepared cantilever strips. These strips were cross-sprayed, cured in air, and heat-treated for 17 hr. They were then oven cooled and cooled in air (see text for details). Total elapsed time between spraying and testing was 22 hr. No attempt was made to control oven humidity, although the room in which the furnace was located was completely air conditioned.

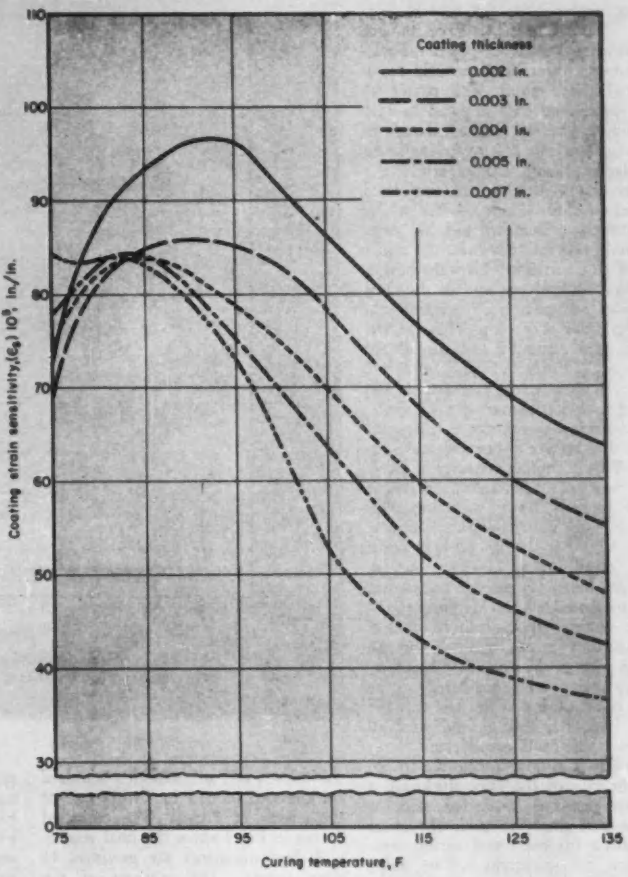


Fig. 2—Influence of curing temperature on strain sensitivity of Coating 1205 for various thicknesses. The strain sensitivity is the maximum strain necessary to crack the coating in the unidirectional state of stress existing on the cantilever strip.

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Armour Research Foundation

BRITTLE COATINGS are commonly used to determine the value of the maximum stress concentration in a machine structure or component. This is not, however, their only nor their most important use. Often it is more important to redesign a part to save material than it is to keep the maximum stresses below predetermined limits—and this can be done only by making an accurate analysis of the understressed zone.

The solution of these two different types of problems requires coatings of different characteristics: (1) a coating of high accuracy and only average or low sensitivity for the stress concentration determination; and (2) a coating of high sensitivity for the analysis of low stressed zones. In the latter case, a decrease in accuracy is not of paramount importance. But when both stress concentration factors and understressed zones are to be investigated, coatings with both high sensitivity and accuracy are required.

One method of obtaining increased sensitivity during the test is the use of an etching solution. Another is to lower the temperature of the coating while making the analysis. Then, too, if it is necessary to construct models for the test, these models can be made out of aluminum or other materials with a low modulus of elasticity; the lower is the modulus, the higher is the strain for the same stress, thus indirectly giving the same result as with a more sensitive coating.

But perhaps the simplest method of increasing coating sensitivity is to use a higher numbered coating as designated by the manufacturer. In the past this technique has been limited because these higher numbered coatings tend to craze, (ie crack without external loading), during the curing period. It has been found, however, that heat-treatment of the coating during the first part of the curing period decreases the temperature at which crazing starts and at the same time increases the final sensitivity of the coating. Toward this end, research has been conducted at Armour Research Foundation in an effort to make a systematic study of the influence of heat-treatment on coating behavior.

To study the influence of the heat

treatment on the sensitivity of the coating, a series of tests were run at various curing temperatures for several coatings. The specimens, a large number of standard cantilever beam calibrating strips, were simultaneously cross-sprayed (in a group with passes 90 deg apart) and then allowed to cure 5 minutes before being placed in forced-convection heating ovens at an established curing temperature.

The strips remained at this fixed temperature for 17 hrs, after which the heat was shut off and the oven allowed to cool slowly for 2 hrs under forced air circulation. Next the blower was shut off and one end of the oven lid was propped open slightly for another hour of cooling. Finally, the strips were removed and cooled for 2 hrs at 75 *F* dry bulb and 60 *F* wet bulb (the constant temperature and humidity conditions of the air-conditioned testing room) for a total time of 22 hrs between spraying and testing. This technique ensures a fairly low rate of temperature decrease, which in turn lowers the chances of crazing. For comparison purposes some strips were cured without heat treatment, remaining at 75 *F* for the entire 22 hours. Coating thicknesses were measured with a Magnegage.

No attempt was made to control the humidity in the oven during the curing process. The absolute humidity in the ovens was considered to be fairly constant due to the fact that the ovens had little leakage and were all within an air-conditioned room.

Since it is almost impossible to obtain coatings of the same thickness, a separate test was conducted prior to the heat treatment to study the effect of coating thickness and curing temperature on sensitivity. The strips were sprayed with Stresscoat 1205 manufactured by the Magnaflux Corporation, and cured at temperatures of 75, 79, 82, 95, 106.5, 115, and 135 F with variations in coating thickness. The results obtained from the average of many strips are shown in Fig 1, and the data of Fig 1, plotted with coating thickness as the parameter, is shown in Fig. 2. The ordinate, strain sensitivity, is defined as the minimum strain necessary to crack the coating in the unidimensional state of stress existing on the cantilever strip. Sensitivity is defined as the inverse of strain sensitivity.

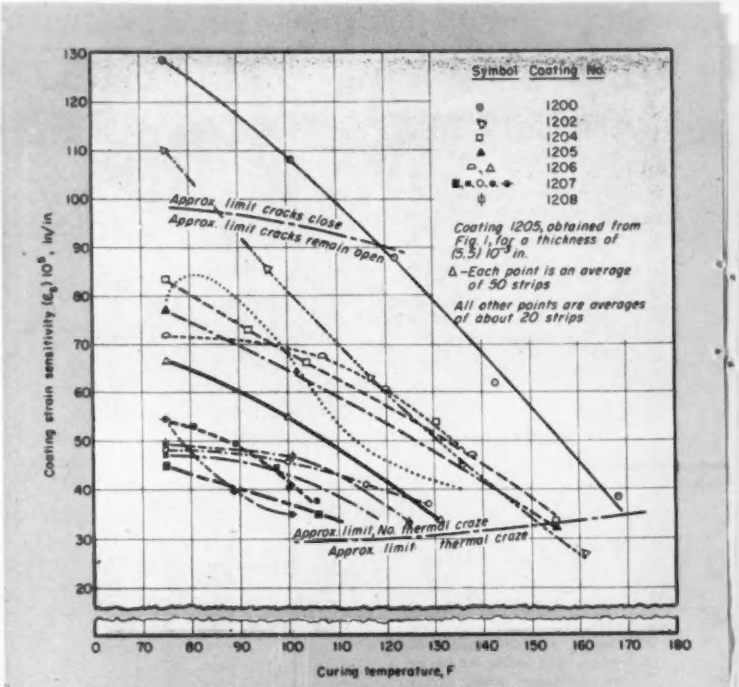


Fig. 3—Strain sensitivity as function of curing temperature corrected for a standard coating thickness of 5.5 x 10^{-4} in.

Analysis of Data

With the completion of the above test, the results obtained from the tests conducted to study the influence of heat-treating temperature were corrected for difference in coating thicknesses and adjusted to a standard thickness of 0.0055 in. by the use of the curves in Fig 1. The corrected curves in Fig 3 show the final results.

A few comments are pertinent to these curves. The portions of the curves in Fig 1 for a normal coating thickness of 0.005 to 0.006 in. show a slight increase in strain sensitivity for slight increases in curing temperatures up to a certain maximum. Above this, a rapid decrease in strain sensitivity occurs with increasing curing temperatures. The flatness of the 79 F and 82 F curves as compared to the curves for 106.5 F and greater, indicate that when curing at the higher temperatures, considerable care must be taken to produce a coating of constant thickness to minimize variations in strain sensitivity.

It is interesting to note in Fig. 2 that the strain sensitivity for thin coatings less than about 0.0035 in. cured at temperatures up to approximately 107 F is higher than that for the same coatings cured at 75 F. At any given temperature over approximately 90 F, the strain sensitivity increases with decreasing thickness. This fact may be explained by a consideration of moisture effects. The heated coatings have had only 2 hrs to absorb moisture, and when they are thick, this time may not be sufficient to complete the water absorption process. If the coating tensile strength is assumed to be constant, an increase in strain sensitivity with an increase in moisture would indicate that moisture tends to decrease the modulus of elasticity or to increase the ductility, and therefore, more strain is required to produce a coating failure in the form of a crack. On the other hand, when the coatings are not heat-treated, strain sensitivity increases with the coating thickness beyond 0.0035 inch.

Above a certain minimum curing temperature, the strain sensitivity varies inversely as the curing temperature. This increased brittleness may be due to decreased tensile strength, increased modulus of elasticity, increased residual stress, or to any combination of the factors.

The curve corresponding to one of the tests of Coating 1205 in Fig. 3 was obtained from interpolated data from the curves in Fig. 1 giving this

Fig. 4—Brittle coating stress analysis of a valve under internal pressure. The rectangular grid helps to locate the points on the three-dimensional surface. The thin lines are cracks in the coating and coincide with isostatics. The heavy lines are isoentatics and connect the cracks' ends after each load increment. The figures on the isoentatics give the corresponding load in ten of pounds of pressure per square inch. Observation indicated that fillets were the weakest points, and that zones not cracked at 150 psi pressure were overdesigned. A less sensitive coating would not have allowed the determination of these low stress zones without plastic deformation.

coating strain sensitivities as function of thickness. This test shows that for 85 F there is an increase in strain sensitivity over the strain sensitivity obtained at 75 F. This increase is not apparent in any other curve. It should be noted, however, that no values are recorded for 85 F in any of the other curves, and it is, therefore, possible that the slight increase shown by Coating 1205 might also be found in other coatings.

In Fig. 3, the approximate limit of thermal crazing has been indicated; it is difficult to obtain strain sensitivities below this line, but a rate of temperature decrease lower than the one used in the tests might result in a lower limit line. Also indicated in the same illustration is the approximate limit of the zone in which the cracks remain open after the load removal. This line also is probably a function of the speed and time of load application. When the load has been applied for one second or more, and removed in the same length of time, the points above this line will correspond to coatings having cracks that close up after the load has been removed. For faster speeds of loadings this limit line will move downward.

An example of a complete stress analysis using heat treated brittle coatings is shown in Fig. 4. This valve is complex in shape and the determination of the points of stress peaks were as important to the designers as the determination of the low stress zones. The grid of perpendicular straight lines was drawn to facilitate the location of the points on the three-dimensional surface. The figures on the heavy lines, which are defined as the loci of points of crack ends and known as isoentatics, correspond to the amount of load in tens of psi of internal pressure necessary to bring the crack end to that position. The higher the figure on the isoentatic, the higher was the load necessary to crack the coating; therefore, the higher numbered isoentatics indicate lower stresses. Assuming that the coating breaks when the material underneath reaches a certain value of stress (a common assumption in industrial application although not strictly speaking correct) the formula giving the maximum tensile stress anywhere in the cracked zone, for a standard load p_s, is:

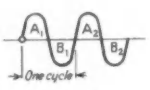
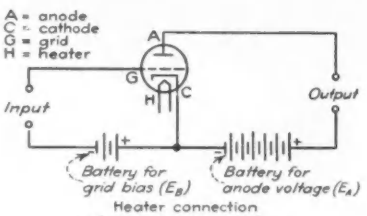
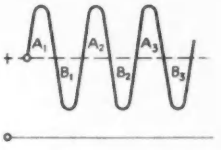
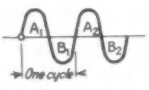
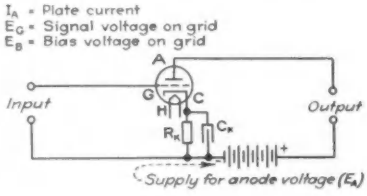
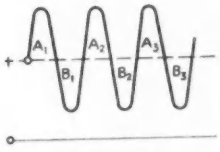
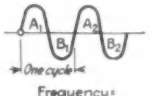
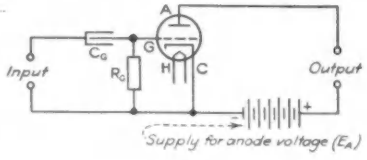
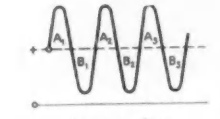
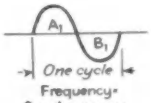
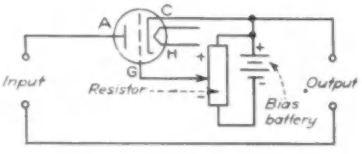
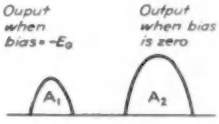
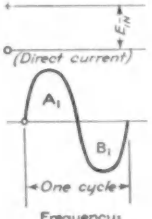
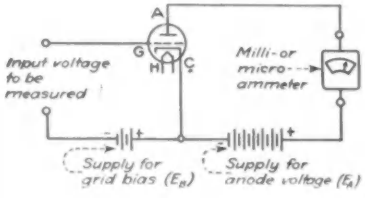
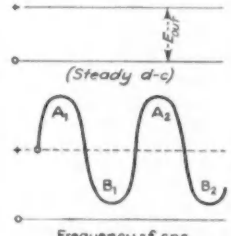
$$\sigma = E\epsilon_s \frac{p_s}{p_i}$$

where p_i is the load corresponding to the particular isoentatic passing through the point: E_s is the strain sensitivity of the coating and E the modulus of elasticity of the valve material. Supposing that in this particular case, E_s is 0.0005, E is 30,000,000 psi, and the standard load is taken as 100 psi internal pressure. Then the maximum tensile stresses will be given by

$$\sigma = 15{,}000 \frac{100}{p_i}$$

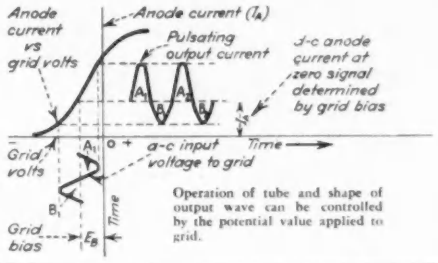
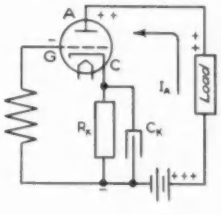
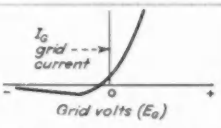
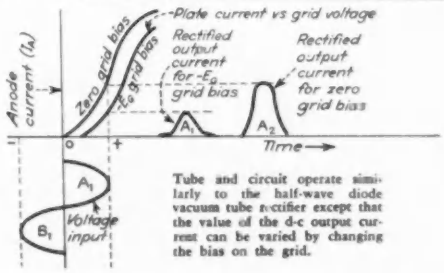
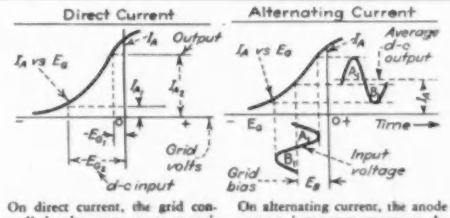
From observation of the photograph, the following points are obvious: (a) the fillets where the cracks appear at a 60 psi pressure are the weakest zones on the outside of the valve; (b) zones not cracked at 150 psi pressure are overdesigned and could be made lighter if there were no other considerations involved; (c) when the 150 psi pressure was applied, the maximum tensile stress in the valve was 37,500 pounds per square inch.

Obtaining Bias Voltages in Triode

Type	Input Voltage	Circuit Sketch	Output Voltage
Battery Bias	 A-c sine wave Frequency = f cycles per sec	 Heater connection and power supply not shown	 Frequency = f cps (Pulsating d-c)
Self Bias or Cathode Bias	 Frequency = f cycles per sec		 Frequency = f cps (Pulsating d-c)
Grid Leak Bias	 Frequency = f cycles per sec		 Frequency = f cps (Pulsating d-c)
Use of Bias in Grid Controlled Half-Wave Rectifier	 Frequency = f cycles per sec		 Major ripple frequency = f cps (pulsating d-c)
Vacuum Tube Voltmeter Circuit	 Frequency = f cycles per sec (Alternating current)		 Frequency = f cps (Pulsating d-c)

Vacuum Tubes

RALPH B. IMMEL
Westinghouse Electric Corporation

Operation	Remarks
 Operation of tube and shape of output wave can be controlled by the potential value applied to grid.	Bias is the fixed voltage applied between the grid and cathode electrodes of a triode vacuum tube. In an unbiased triode, anode current is an amplified function of the a-c voltage signal impressed on the grid, as can be seen from the accompanying graph of anode current vs grid voltage. Biasing the grid has the effect of shifting the axis of the a-c input voltage to the grid to the right or left, depending on whether the bias voltage is positive or negative. Thus, the triode can be made to operate at any section of its anode current vs grid voltage characteristic by selection of the appropriate bias voltage. The grid bias and anode batteries may be replaced by electronic rectifier and filter circuits.
 The anode current (I_A) through the cathode resistor R_K provides a voltage drop which biases the grid negatively with respect to the cathode. The cathode by-pass condenser C_K is used to shunt the a-c component of the anode current from the resistor. An a-c component through the resistor R_K would cause an a-c voltage drop which in turn would produce negative feed-back. Feed-back reduces the amplification.	Self bias or cathode bias should not be used in a circuit or application where the anode current varies. A variation in anode current and bias resistor drop will change the point on the characteristic curve at which the tube operates. Self bias is often used with Class A amplifiers, because it is inexpensive and because the d-c anode current is substantially constant with or without input voltage on the grid. The grid bias for most applications is usually negative, since a positively charged grid will draw electrons from the cathode and decrease the net anode current.
 When the grid is driven positive, electrons flow from the cathode to the grid. The time constant of the condenser C_g and the grid leak resistor R_G is large compared to the period of time the grid is positive. Therefore more electrons are imposed on the grid circuit than can immediately leak off through the resistor or return to the cathode through the tube. The trapped electrons stored in condenser make grid negative with respect to the cathode.	Grid leak bias is mainly used for control in radio frequency power amplifiers and some detector circuits. In any case, this type of grid bias cannot be used when the grid is always negative with respect to the cathode. The grid must be operated at positive potential at least part of the time in order to draw grid current and produce a voltage drop in the grid leak resistor R_G or an excess of electrons on the grid.
 Tube and circuit operate similarly to the half-wave diode vacuum tube rectifier except that the value of the d-c output current can be varied by changing the bias on the grid.	The output voltage and current of a triode vacuum tube rectifier can be varied by adjusting the grid bias potential. For the circuit shown, the output current is a maximum when the grid bias potential is zero. The output current value can be reduced by applying negative grid bias to the grid of the tube. If the grid bias circuit is arranged so that the grid may be made positive with respect to the cathode, the output current can be made to exceed that which flows at zero grid potential.
 On direct current, the grid controlled tube operates as a variable resistor. The anode current instrument is calibrated in units of input grid volts. On alternating current, the anode current instrument measures the average value of the pulsating d-c output current. The current is proportional to the a-c input.	As a vacuum tube voltmeter has a relatively high input impedance, it is very convenient to use for very accurate measurement of both d-c and a-c voltages up to very high frequencies. Because the vacuum triode tube output is controlled by an electrostatic field emanating from the grid, little or no power is taken from the circuit to be measured. All a-c vacuum tube voltmeters are essentially rectifiers which can be calibrated to read the rms, average, or peak values of the voltage input. This type of voltmeter can be made almost independent of frequency or wave form. A special coaxial probe is usually used for voltage measurement of frequencies above a megacycle.

Noise and Vibration in Ball Bearings

GEORGE H. KENDALL

When products are rejected because of faulty bearing operation, the designer is often called upon to trouble-shoot. He should be able to recognize the symptoms and identify the causes. Study of the latter shows that certain design precautions can be taken to make products less susceptible to bearing troubles.

IN ROTATING MACHINES, noise and vibration are indications of faulty operation of ball bearings. More often than not trouble is traced to the design and assembly of the machine rather than to the bearings themselves. The technology of their manufacture is such that ball bearings in general are precise and reliable components. Therefore, the satisfactory performance of bearings in the assembled product is clearly the responsibilty of design and production.

The balls in a bearing require an absolutely parallel track to roll upon, entirely free from eccentricity, wobble or other variations. Study of the bearing illustration, Fig. 1, discloses what can happen to destroy this accurate mechanism if a lack of squareness of mounting the bearing exists in any perceptible degree. Should the inner ring be cocked to a tilt position, the balls are forced to climb one side of the raceway during part of a revolution, with resulting drag on the bearing retainer. Then, the balls accelerate down the raceway to climb the opposite side in the other part of the revolution, reversing the strains on the bearing retainer. The balls instead of rotating about a true horizontal axis tend to spin from contact with the sides of the raceway and to reverse their direction of spin during the second half of the revolution.

Some degree of lack of parallelizm or squareness of the rings or associated parts is permissible before bearing performance is considered unacceptable under commercial standards. As this subject covers a wide range of speeds and types of products, it is expected that certain variations in the acceptance standards exist. But long experience has shown that practical limitations can be located in a general way and illustrated in graph form, as in Fig. 2. The lower curve represents the tolerance requirements for products having more critical performance standards; the middle curve, the average; and the upper curve, the less critical products. The graphs are plotted from actual existing commercial standards and can be used for most products with accuracy, because the factors influencing performance hold about the same relation throughout the range of types of construction in any specific speed classification.

Misalignment is, of course, not the only cause of improper bearing operation. However, it is a fault that is clearly related to factors of design. Some constructions are more liable or sensitive to misalignment than others. Internal looseness, excessive end play and improper shaft fit also lead to bearing troubles, which usually are indicated by noise and vibration.

Noise is probably the most common cause of rejection, simply because it covers the most ground and its existence is so noticeable. By noise is meant those sounds objectionable to an inspector's standards of operation. Since the human factor is involved, such noise evaluation is not an absolute test. The level at which sounds become annoying is not the same for all persons. Except for borderline cases, however, inspectors agree consistently on whether or not the noise in a bearing under test is objectionable. A more positive evaluation of bearing noise can be obtained by use of sound meters, with or without benefit of "quiet room" test conditions.

Once it is decided that a bearing is

Fig. 1—When either race of a ball bearing is tilted in respect to the other race, the balls cannot travel in a true radial path. The balls climb one side of the raceway during part of a revolution, then climb the other side in the next half revolution. The resulting ball path is shown at right.

Fig. 2—Graphs showing the approximate misalignments that can be tolerated at various shaft speeds before faulty operation is noted. Each of the curves relates to a definite class of applications having similar limitations on noise and vibration. In the most critical class, a high degree of quietness and freedom from vibration are called for as in hot water pumps for homes.

noisy, the cause can often be determined immediately from the nature of the sound. Most bearing faults can be associated with definite types of noise.

Loose Clearance of Balls

Internal bearing looseness is usually identified by a high, even tone or rattle. It may be quickly checked by pressing axially against the end of the shaft with a pointed wood stick. If looseness is the only trouble, this action will immediately lessen the noise. Heavy duty small motors and other rotating machines for everyday service at moderate speeds are often supplied with bearings of a medium fit to permit some latitude in the assembly of the inner ring on the shaft. When mounted, the axial play range is normally between 0.0025 and 0.0045 in. Applications for high speeds or requiring above average quietness, have bearings of a tight fit with an axial play range in small units of 0.0010 to 0.0025 in. This is strictly axial play and not radial play, which has a value of about one-seventh to one-eleventh of these figures.

Where only one of the two ball bearings is relatively loose in internal fit, any trouble in either bearing usually adds to the noise in the loose bearing, regardless of whether or not it originates there. Factors such as unbalance, bent shaft or wobble stand out in this respect by greatly increasing the magnitude of noise, even though the trouble may be at the opposite end of the unit. If noise control is essential, care should be taken to have both bearings in about the same internal lateral fit range.

High, singing noise in a bearing may signify one of three common things: dirt in a high speed bearing, rust at any speed, or radial preload from a too-tight shaft mounting. More rarely, windage noises from slight pressure differential currents in a fan or blower unit are of this character. The trouble may be localized by removing the shaft from the housing. The outer ring of one of the bearings should be held so that the shaft is vertical. When the shaft is spun, the fingers will detect roughness if rust or dirt is present. Dirt tends to cause a drag in the slow-turning bearing so held, but rust does not. The bearing at the opposite end should be checked also, as noise sometimes is generated from an entirely different place than is initially supposed when the unit is running.

A high radial preload, produced by forcing a bearing on a shaft too large for normal practical fit, will expand the ring until no internal play remains. This condition is easily checked by trying to move the bearing outer ring sideways. An excessively preloaded bearing has no sideways freedom and appears to produce a decided drag on the slowly turning shaft when the bearing outer ring is held in the hand. Any "windage sing" can be identified by covering ventilation openings in the housing. This should result in changing the noise tone or stopping it altogether. Noise from this condition will change more rapidly with varying speed than will noise from the three other conditions and it will completely disappear at lower speeds. Although windage noises are not related to bearing troubles, bearings are usually suspect until the troubleshooter proves otherwise.

Shrill Noises and Chatter

An extremely shrill noise arises from raceways, end shields or ball retainers that were damaged or imprinted from light hammer blows. In these cases, the tone changes with the speed of the unit, but does not die out at low speeds. A feeling of roughness will be evident when the shaft is turned slowly by hand.

Chatter indicates too large a bore in the housing so that the bearing outer ring creeps and chatters from its own or other vibration in the unit. Chatter of this sort may be difficult to locate where a rough housing bore exists. The minute peaks and valleys in the bore surface provide a fit which may seem on first assembly to be tight. But, with the vibration encountered in use, the bearing becomes loose as these peaks wear down. This fault is one of the common and recurring troubles found on production lines where tone quality control is rigidly required by the acceptance standards of the product. Cure for this trouble is to provide a smooth surface bore in the housing, held strictly within tolerances. Chatter may also be controlled by painting the housing bores just before bearing assembly with a very heavy viscosity oil, above 3,000 Saybolt. The thin film on the broad surface of the circumference prevents chatter effectively, and appears to hold its initial qualities upon examination after two years of

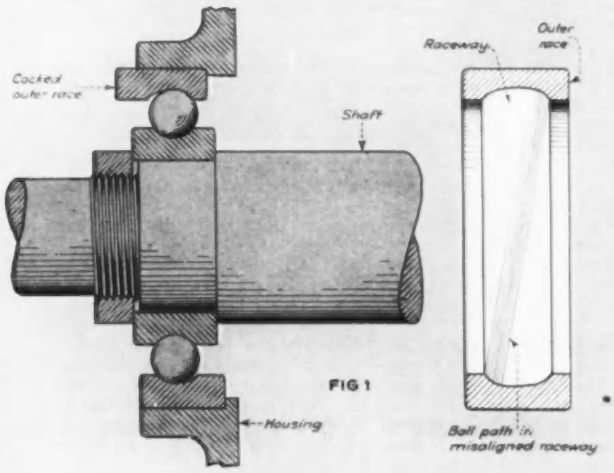


FIG 1

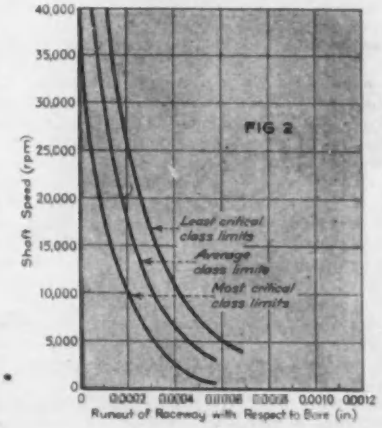
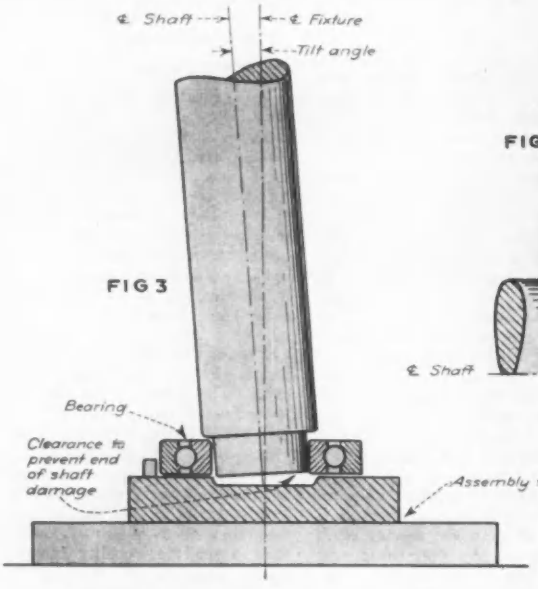


FIG 2



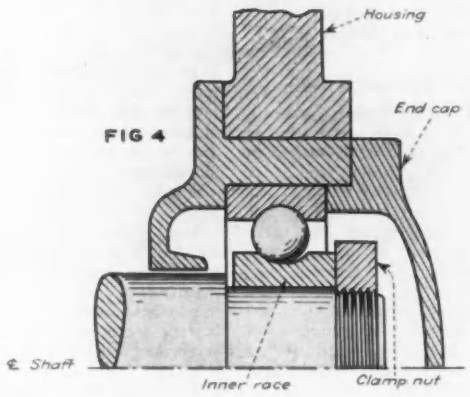
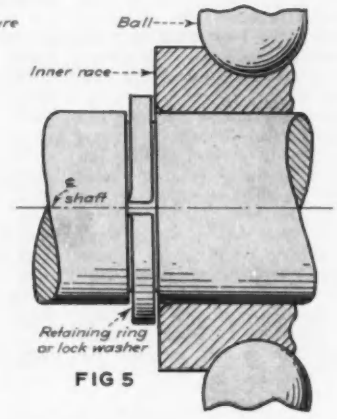


Fig. 3—Improper fitting of bearing on shaft can occur whether bearings are hand pressed or arbor pressed. Sketch above shows fixture used in bearing assembly. Unless upper end of shaft is centered correctly in the fixture before pressing, bearing and shaft will be in misalignment.

Fig. 4—In above design, the end cap is used to clamp the bearing outer ring. Trouble arises if the cap is machined improperly so that the face against the outer ring is not parallel to the face against the housing.

Fig. 5—Use of retaining ring on straight shaft to position the ball bearing. In this type of construction, proper alignment of bearing is more difficult to attain than if the shaft had a machined shoulder.



continuous service. It is also somewhat effective in dampening noise from other causes.

Smooth tone quality or lack of objectionable noise is a common objective in design of high speed motors or similar units. The conventional unit often has a flat spring washer to take up axial or lateral play. This tends to lessen variations of tone, which sometimes reaches the chatter stage from outer bearing ring creep. Noise from "looseness" is at its loudest in those units that, by chance, have been assembled of components, all or most of which are at the extremes of their dimensional tolerances. The cumulative play in these components is considerable.

The spring is intended to take up all of these variations and is required to keep a nearly constant pressure on the bearing outer ring. Any major increase in pressure will cause preload troubles, with resulting heating and loss of speed or performance efficiency. Another function of the spring is to grip the bearing outer ring to stop turning, which otherwise might cause creep and chatter. Use of long springs, of double flat spring washers or other compressible elements, such as synthetic rubber washers, effectively provides uniform tone quality over the range of production tolerance variables.

One noise may be overlooked in trying for tone quality. This is grease slap, an intermittent click or slap noise coming from a double-shielded bearing when the unit is first started on run-in test. This is simply a part of the channeling process, does no harm and disappears in a short time. The duration of the noise depends on the quantity of grease in the bearing and the speed of the unit.

Vibration

In this case, vibration is considered only for its relation to noise; not for fatigue or other effects. To be objectionable from this standpoint, the vibration is above moderate amplitudes and can be measured by hand feel of the unit being tested. Unless looked for specifically, vibration seems harmless enough during test, but shows up after being put in service. In quiet surroundings, for example, the vibration is detectable as a noise. Or, when the unit is incorporated in a cabinet with other equipment, the flat surfaces act as sounding boards for the vibration.

Lack of dynamic balance is a fre-

quent source of trouble. It is recognized by an extremely strong and sharp vibration, which prevails on rundown test until the unit is well below the critical speed. Static balance will not provide dynamic balance. If highly uniform tone control is required, a fine degree of dynamic balance is called for. Use of balancing machines may be needed. If dynamic balance is satisfactory, other vibration troubles may be identified by the steady run and rundown tests.

Bent shafts, double bent shafts, or whipping shafts produce sharp vibrations that feel almost the same to the hand. However, vibrations from the first two causes retain their intensity on rundown until the unit is almost stopped, far longer than is the case for pure dynamic unbalance vibration. Shaft whip disappears at certain critical speeds and may be most easily located by use of a stroboscopic tachometer. Bent shafts may be of simple bend or compound bend, depending upon the handling. The bends vary as to location over the length of similar shafts. Long, thin shafts are, of course, the most susceptible to bends. Rejections commonly mount from one to twenty percent and back again in a single day from this cause. The magnitude of the shaft bends that bring trouble run in the order of other off-square variables shown in the graph, Fig. 2. While soft, thin shafts may be strong enough for a given application, experience shows that more rigid shafts pay dividends in attaining uniformity in tone quality.

Wobble of mounted bearings represents a major cause of trouble where provision is not made for the proper proportion of the shaft shoulders. This trouble is recognized in a running unit from the magnitude of vibration, which is heavy like that from dynamic unbalance. Wobble vibration continues until the unit has almost stopped on a rundown test. When the shaft is turned slowly by hand, wobble can sometimes be identified by a slight drag resisting rotation. Wobble or cocking of the inner ring is commonly caused by either of two factors. An excessively small shaft shoulder may cause the bearing corner radius to ride onto the shoulder at one point. Or, wobble may result where assembly fixtures for pressing the bearing on the shaft do not mount squarely as depicted in Fig. 3. Once again, the graphs on Fig. 2 show the allowable variations in alignment before vibration becomes excessive.

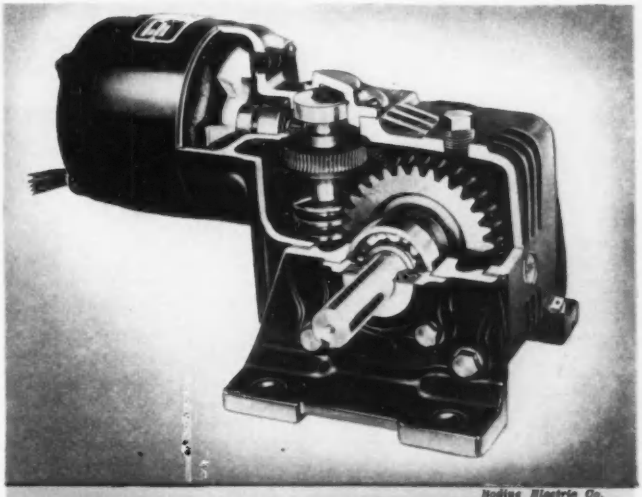
Hand press assembly, used by many manufacturers where a hand push fit is satisfactory, tends to produce a surprising number of wobble rejections. Slight unevenness at the shaft shoulders tends to prevent accurate seating of the bearing on those shafts in the tighter fit end of the tolerance used. This results in the inner ring being in a tilt position. A small arbor press to positively and squarely seat the bearing inner ring is fast, efficient, and stops this common cause of vibration.

Small shaft shoulders in some cases are not uniformly cut or the tool is not given time to "clean up" before being backed away, so that the necessary degree of shoulder squareness is not provided. These faults also increase the probability of rejection for vibration reasons.

In units having long, thin shafts, vibration can be caused by parts mounted on the shaft extension if these parts are only statically balanced before assembly with the shaft. The possible result is heavy vibration, which is sharpest at the back end of the unit, away from the shaft extension. Where the back bearing has more internal lateral play than the front bearing, this condition will be accompanied by considerable noise in the rear bearing. In high speed units of this type, shaft whip also enters the problem and increases the possibilities of rejection. Short stocky shafts and extensions are the cure for rejection from these causes, along with a proper degree of dynamic balance for the parts mounted on the short extension.

Noise and vibration often develop in units where, as in Fig. 4, end caps inclose and clamp the bearing outer rings. The trouble arises when the caps are machined improperly so that the face against the bearing outer ring is not parallel to the cap flange face against the housing. Designs using die castings are particularly liable to this trouble unless the surfaces of the casting are finished.

Trouble of this type can be isolated during a steady run test. Noises from defective gear teeth, looseness, or other causes will seem to come from the floating bearing which is opposite that held by the clamping cap. The reason for this is that the fixed bearing ring is cocked or tilted when the out-of-square clamp cap was tightened, so that no internal play remains in that bearing. Thus, it cannot chatter as readily as the floating bearing. This trouble can be checked by loosening one bolt or cap screw of the clamp cap at a time, listening for immediate change of noise, and tightening again. If this does not show results, the test should be repeated by loosening two adjoining bolts at one time. This method will also indicate the direction in which the cap is tilted. Clamp cap trouble may occur at the closed end or shaft



Bodine Electric Co.

Fig. 6—Cutaway view of combined motor and gear reducer drive unit. The high number of bearings employed in this unit calls for design precautions against noise and vibration. All rotating parts from armature to output shaft are close-coupled. Shafts are short and of rigid construction.

extension end of any construction, wherever a bearing is clamped. In some cases, a slight or fairly perceptible drag is felt when the shaft is turned slowly by hand. If the shaft is also bent or the bearing inner ring is cocked, the drag will be more pronounced at certain points of rotation.

Vibration of a similar nature arises from clamp nuts and threads cut on the shaft. If the threads of both are not cut in the proper relationship with the axis of the shaft, the bearing and clamp surfaces may be in misalignment and wobble may result. This is especially true of tight fitting threads. The clamp nut should be free-turning with a slight amount of play between the shaft and nut threads. Such play effectively absorbs out-of-squareness and prevents cocking of the ball bearing inner ring. In some cases, a cocked bearing may result in bending of thin shafts, causing unbalance in running tests.

Units with One Ball and One Sleeve Bearing

For economy of construction, many of these units have straight shafts without shoulders for locating the ball bearings. Instead, retaining rings are employed to position the bearings, as in Fig. 5. To a certain degree, such construction is successful in applications where noise or vibration are not objectionable. But, where smooth and uniform tone requirements exist, quality control is somewhat of a problem. Use of a retaining ring requires the turning of a locating groove in the shaft. The allowable variations in the dimensions of both ring and groove are such that play of between 0.0005 to 0.0170 in. commonly exists. Reference to the curves of Fig. 2 discloses that at slow speeds the smaller values are not serious. But at higher speeds this wobble becomes troublesome. When a bearing is clamped against a retaining ring, the wobble is sufficient to cock the bearing inner ring and in some cases actually bend the shaft. Such a condition is identified on the steady run test by a heavy vibration, considerably sharper than that produced by lack of dynamic balance. Use of a thin drawn tubing in short lengths shrunk on the shaft is a successful and economical means of providing square shoulders for locating bearings in mass produced units.

Although a bend in the shaft at the sleeve bearing end of the unit is remote from the ball bearing, this condition produces knock at the ball bearing at the point of greatest misalignment. The trouble may be identified by adding a few drops of oil at the sleeve bearing while on the steady run test. The oil slightly dampens the knock magnitude of vibration, but will not eliminate it. If the knock is due to a damaged or imprinted ball bearing, the adding of oil at the sleeve bearing does not materially change the magnitude of the knock or hammer noises.

Another reason for rejection in the one ball bearing—one sleeve bearing type of construction arises from damage to the shaft at the sleeve bearing end. Nicks, cuts or bosses, caused by blows on soft steel shafts are sources of noise. During a steady run test, hammer noise develops at the ball bearing. In some cases, the hammer is felt also at the sleeve bearing end, but much less in intensity. The noise is caused by the nicks or cuts as they strike the oil hole or grove in the bushing. This difficulty can be distinguished from ball bearing imprint trouble because the noise from the former is much greater. This condition may be further identified by rolling the unit over slowly on the test stand during the steady run test and noting the change in the tone quality of the noise or hammer that results. Because the nicks, cuts and raised spots usually appear at the sleeve end of the shaft, a slight taper or undercut at this end proves helpful in avoiding such damage. Covering the sleeve portion of the shaft with a paper tube is also effective. However, good materials handling planning that provides protection from rough, rushed, or abusive handling is the optimum cure for this source of noise. Burrs at the oil hole in the sleeve bearing may also contribute to the trouble.

Sleeve Bearing Clearance

Uniform and even tone quality in the operation of small units requires that the sleeve bearing be held closely to the tolerance specifications regarding shaft and bushing bore dimensions. Since this tolerance is usually small and because a smooth surface finish is desirable some designers now specifiy work hardening of the bushing after assembly in the housing frame by ball drift, burnishing, or

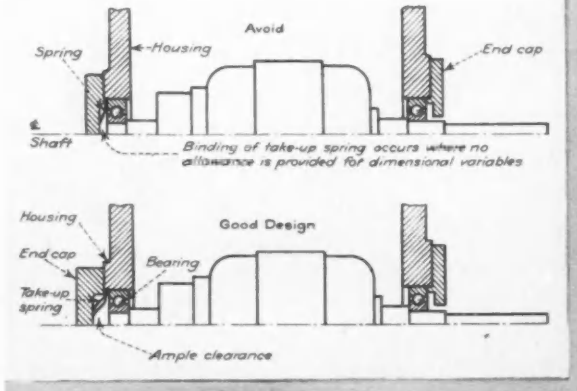
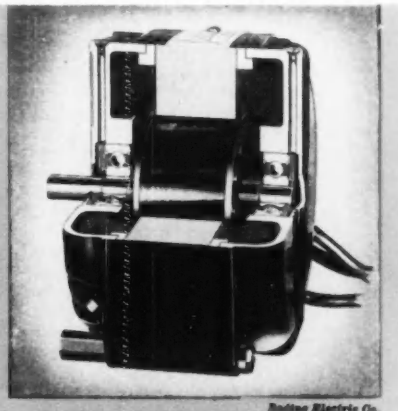


Fig. 7—Cumulative tolerances must be considered in design of bearing assemblies. For example, take-up spring (top sketch) is rendered ineffective by binding. This occures when parts are at the extremes of their tolerances causing take-up of all clearance in the end cap.



Bodine Electric Co.

Fig. 8—Motor designed for quiet operation. Shaft distance between bearings is short to avoid shaft whip. Inner races of ball bearings are positioned by machined shaft shoulders.

Bearingizing operations, chiefly of a sizing nature. For speeds up to 10,000 rpm, the general practice is to keep shaft and sleeve bearing clearance within tolerances of 0.0004 to 0.0008 in. Greater clearances can result in noises sufficient to bring about rejection. Clearance values below the minimum increase the possibilities of heating troubles from minor misalignments. The shaft finish for the sleeve bearing should be smooth and as free from grinding scratches as possible when long operating life is required. Recent tests have demonstrated that a high finish is capable of lengthening sleeve bearing life and of maintaining the initial tolerances throughout a longer period of service. If continued quiet operation is to be assured, the sleeve bearing clearances must be held fairly constant. Excessive wear quickly changes the clearances, resulting in rapid deterioration of tone quality.

The one ball bearing—one sleeve bearing unit provides no means of correcting for excessive lateral or axial play. No take-up springs are provided like those in the two bearing unit. Thus, in horizontal units the ball bearing tends to run in the center of its ball track so radial looseness can exist. In vertically operating units, this axial play is taken up by the thrust of the parts on the ball bearing.

The unit is therefore sensitive to changes in sleeve bearing clearances which magnify the generation of noise from faults such as unbalance and shaft whip. The oil film at the sleeve bearing cushions and dampens noise and vibration at that end of the unit. Hence, the effect of all variables appears at the ball bearing end of the unit, whether this be the closed or shaft extension end of the assembly. The design engineer, therefore, should keep the ball bearing in the tight fit range. It is important also to design and specify the shaft and associated parts so as to assure straightness, squareness, rigidity and good dynamic balance.

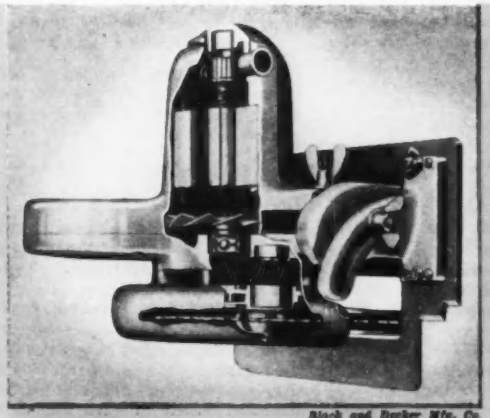
Heating

Heating from axial preload may be caused by expansion of the rotating parts, with the result that all of the end play available at the floating bearing location is taken up. Or the axial preload may arise from the chance assembly of housing parts at the lower end of the allowable tolerances with rotating parts that are at the higher end of the tolerances. As can be seen from Fig. 7, such a combination would take up all end play and cause binding. Heavy preloads may be placed on the bearing by either of these causes. Yet it is difficult to determine the magnitude of these loads during test because turning the shaft by hand slowly discloses only a slight drag or "tight" feeling. The design engineer should allow a more liberal degree of take-up to prevent this condition by summing up the dimensional tolerances of all of the parts involved. Axial play take-up should provide a nearly uniform pressure over a wide dimensional variation, rather than a rapidly changing pressure condition for slight dimensional change. This must be accomplished, of course, in the design of the axial play take-up spring, Fig. 7, or compressible member serving this function.

Axial preload may also occur where housing fits are too tight to allow the floating position bearing to function. This can be checked by loosening of the housing bolts, which should immediately free the preload and improve the tone quality and speed of the unit.

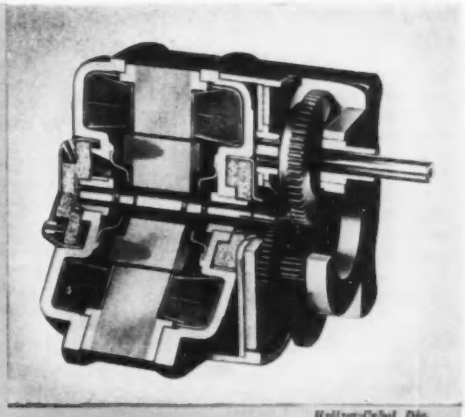
Heating from radial preload is caused by insufficient internal play in the bearings and is rare. A false condition paralleling this is sometimes created by mounting a close-fitting bearing on an oversize shaft. The inner ring expands from being forced on the shaft, takes up all internal play and establishes a preload. This condition, however, rarely reaches the assembled unit stage where a hand test of outer ring movement is made to check lateral play and free turning condition of the bearing.

The more common electrical troubles of noise-making proportions may come from factors such as an improperly designed brush or commutator, excessively small air gap, an insufficient number of armature slots for the application, an intense field with magnetic flux currents of disturbing values, and skewed armature or rotor cores. These may or may not produce vibration noises that are transmitted to the ball bearings. Sometimes, to prevent electrical noise from complicating the problem, it is of value to drive the unit from another motor.



Black and Decker Mfg. Co.

Fig. 9—Because sawing is a noisy operation, bearing noise may not be objectionable in a power saw. But vibration is undesirable. Shafts are short and bearings carefully aligned. Closed housing protects bearings from dust.



Hallett-Cabel Div.

Fig. 10—In sleeve bearing units, short shafts and close coupling minimize shaft whip, which causes bearing knocks. Nicks on bearing surfaces of shaft or bushing is another source of difficulty.

Shall It Be A Job for

Herewith we are presenting, with little comment, a number of the letters received concerning the editorial, "A Job for Engineering Societies" which appeared in the October issue of Product Engineering.

So Father So Son

To the Editor:

As was pointed out in an editorial in the Vancouver British Columbia newspaper, dishonesty in politics is often the result of the lowering of moral standards among the voters.

It is difficult to understand how people who patronize the gambling dens and bet on the horses and play the numbers can get very excited over politicians tolerating illegal gambling or profiting from book makers' operations. Add to this the many many who juggle their income tax reports and you have another army of people whose moral standards have been lowered.

There is an old saying, "So father so son". The same thing in politics. As is the voter so is the man whom he elected. —J. F. BORLAND,
San Francisco

To the Editor:

Just got a look at your October editorial complaining about dishonesty in the government. I think you are wrong in putting the whole blame for corruption on the wrong people.

The framework of the present tax laws have created a vast number of liars and cheats. How many tax returns—in all brackets—are prepared with perfect honesty and without a single falsehood? Cheating by taxpayers has become a national joke.

Government officials come from the ranks of the people. All of them have become hardened to petty or grand larceny after many March 15th's. Election or appointment does not change their stripes. —JOHN F. CONROY,
Port Washington, L. I.

Ed.—Cheating on the income tax often becomes a very expensive joke.

Why of Course!

To the Editor:

Engineering societies, like other professional associations, are effective instrumentalities for establishing and maintaining a sense of honor and ethics in their respective professions. They can help to improve the standards of government administration by exercising their ethical influence through already established channels.

—JACK GORRIE,
Acting Chairman
National Security Resources Board

The Ball Starts Rolling

To the Editor:

Your series of editorials have been most stimulating. I liked particularly their punchy presentation of facts and a direct appeal to action usually with a definite program.

Your last editorial "A Job for Engineering Societies" has been reproduced and I am sending it to all of the engineering societies in Milwaukee. This includes eleven affiliates with the Engineering Society of Milwaukee with a total membership of about 3,000, also about 25 other societies.

I would like to suggest as a service to your readers that reprints of editorials be made available on request. This added initiative on your part would add focus to the editorial inasmuch as you would consider it of such value as to make it available in that manner. Of course the shorter and the higher the quality of the editorial the greater will be its value.

Congratulations and best wishes for continued success. —E. C. KOERPER,
In Charge Special Projects Engineering
A. O. Smith Corporation

Ed.—As to reprints, we will be glad to furnish gratis reprints of editorials appearing in PRODUCT ENGINEERING. Thanks for the suggestion Mr. Koerper.

Women Are Best House Cleaners

To the Editor:

Just yesterday I read the October issue of PRODUCT ENGINEERING. As always we started with your editorial: "A Job For Engineering Societies". Amen. There possibly is another thing that we could do to try to end the political corruption and chicanery so rampart today in our government. It has always seemed to me that women as a whole group are less corruptible and more fair minded than our present male politicians. Isn't there something that could be done on a mass scale that would especially appeal to the women and make them especially politically conscious so that they could bring more political pressure to bear. I do not mean to imply that Republicans are especially virtuous and God's chosen. The present regime has been in office too long and we need a change.

Wouldn't it be nice if Mr. Hoover could live long enough to see all of his recommendations put into effect. This then would go a long way towards the redemption in the public eye that Mr. Hoover so diligently strived to accomplish as his last public service before the Great Architect writes "Finis" to a great man, and an engineer of unquestioned ability.

Your efforts are appreciated here.
—H. L. RATCHFORD,
Engineering Specialist
Sylvania Electric Products Inc.

Ed.—He is claimed to be the greatest administrator who was ever in the White House and F. D. Roosevelt the greatest politician.

Orchids for The Civils

To the Editor:

I have for acknowledgment, your letter of 19 September, transmitting a copy of the editorial "A Job for Engineering Societies."

The editorial in PRODUCT ENGINEERING raises certain questions regarding possible action by professional engineering societies that I feel should receive the benefit of discussion by the American Society of Civil Engineers Board of Direction. According, I propose to refer your editorial and letter to our Board at its meeting in New York City on the 22-23rd of October.

Inasmuch as my term as President of

Engineering Societies?

With only a few exceptions the letters were strongly favorable to the idea expressed in the editorial. We only wish that there had been more letters setting forth other ideas, arguments and viewpoints.

the Society terminates on the 24th of October, you may expect a reply either from incoming President, Carlton Proctor or Executive Secretary, William N. Carey. —GAIL A. HATHAWAY,
President American Society of Civil Engineers

Ed.—Admittedly the "job for engineering societies" will require much study and discussion to determine the best way of doing it. We'll look forward to hearing from the Civils.

Same Idea One Year Sooner

To the Editor:

I am very much interested in your editorial in the issue of October 1951. I hope that you have success in promoting this idea.

I am inclosing copy of a letter on the same subject that I wrote to Mr. Zeder, President of the Society of Automotive Engineers, on August 10, 1950.

—M. E. CHANDLER,
Manager of Engineering & Research Chandler-Evans

Ed.—Mr. Chandler's letter to Mr. Zeder will be published in full in our next number.

A Natural for ASME

To the Editor:

I have discussed your October editorial with two ASME members. They both were inclined to feel that such a move would be a good thing, and perhaps coming from an engineering group, would have material effect on our Senators and Congressmen. The question arises in my mind as to whether it is within the charters or constitutions of the various engineering groups.

I do not think the idea is at all impractical and the more I read in regard to conditions of affairs in our government and among the government officials, the more I feel it is time the public rose and took some definite action to change matters. I do feel however, our biggest effect will be felt at the primaries or polls, and the public, awakening to their responsibility, will make sure that we have candidates who are true, practical men—and patriotic enough to stand up against some of the temptations that are so corrupting some in our present government.

—B. P. GRAVES,
Consultant in Design Brown & Sharpe Mfg. Co.

Ed.—The last sentence of Mr. Graves' letter speaks volumes.

Correct

To the Editor:

It is my firm opinion that industry and each segment of industry, such as our engineers and their societies, must take an active interest in government if we are to have good government and if we are to be successful in world affairs. —R. T. HURLEY,
President Curtiss-Wright Corporation

Yes—We Think Alike

To the Editor:

I have read your editorial on "A Job for Engineering Societies". Of course, I agree with everything that you have said. I could write you at great length on this subject, but I shall not burden you because I believe we think alike on this great problem.

The currency of your business and mine is dollars. Even though they be unstable they are the only flexible measuring stick that we have in our economy. The currency of the politician is votes. We should never lose sight of this fundamental difference in currencies when we are dealing with politicians. They use our currency to produce their currency and in doing so they care not for what is right morally, but only for what is politically expedient.

As I read your editorial, one thought flashed through my mind—that engineers are taught to deal in facts, in truths. They might take as their slogan the old biblical quotation—"Know the truth and the truth shall make you free."

Keep up the good work. We are with you and wish you the best of luck. —A. V. BODINE,
President The Bodine Corporation

A Senator Speaks Out

To the Editor:

I appreciate very much the copy of the article inclosed in your letter which was received in this office October 5. Of course, the question of effectiveness is one which we can only hope for, but I think it is appropriate for such fine groups as the engineering societies to bolster our sagging moral conditions in national affairs. Certainly the picture is a sad one, and everybody should assume the responsibility of helping to correct it before our country is completely ruined.

I think you should be commended for taking the initiative in such a campaign. —HOMER CAPEHART,
United States Senate

Ed.—Republican Capehart of Indiana and Democrat Byrd of Virginia think much alike on some points.

Thanks for the Compliments

To the Editor:

While sitting in the booth at the Metal Show one day, I looked through the October issue of PRODUCT ENGINEERING, and I could not refrain from dropping you a note regarding your fine editorial.

I don't know what it's going to take, but it's going to take something to get our public morals back to an honest state.

Congratulations on the fine article. Keep up the good work.

—A. F. DAVIS
The Lincoln Electric Company

Ed—More men like "Charlie" A. F. Davis is what it will take.

(Continued on page 258)

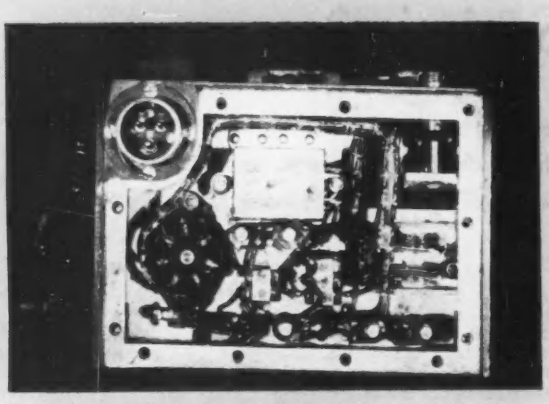


Fig. 1—Extent of mold growth in electrical and electronic equipment used in the South Pacific. Where equipment was stored in holds of ships or in jungle supply depots, conditions for mold growth were ideal.

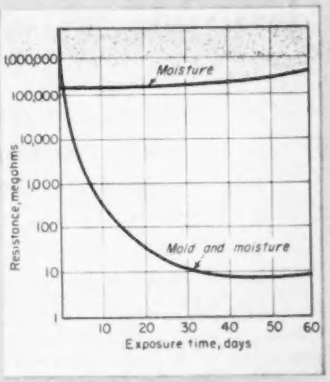


Fig. 2—How moisture alone and both moisture and mold together change the electrical resistance of vinyl insulation.

Effect of Mold and Moisture On Electrical Insulation

J. M. LEONARD
CONSTANCE PATOUILLET
Naval Research Laboratory
Washington, D. C.

CLIMATES THAT FAVOR THE GROWTH OF MILDEW also cause the malfunction of electrical and electronic equipment. It took the war in the Pacific to dramatize that fact and to give it significance. In Fig. 1 is shown a radio receiver that is illustrative of the damage done.

The problem of climatic damage was accentuated, of course, by the complexities of military electronic gear and instruments. Higher frequencies, higher voltages, and the trends toward miniaturization placed an ever increasing premium on the importance of good design and good materials. However, good design and materials must be based on a fundamental knowledge of the nature of mold and the causes of deterioration.

Fungus or mold is a lowly and relatively simple form of plant life. The spore of this fungus is usually a single cell, perhaps 3 to 10 microns in any dimension, that is resistant to desiccation and extremes of temperature. In the dry state, the spor is as innocuous as any other particle of dust, but when it becomes wet or is exposed to a high relative humidity, it starts to grow. The fungus that results does not require a great amount of food, nor is it restricted in its choice of diet: ordinary accumulations of dust and grime suffice.

Electrical equipment on which profuse developments of mold are formed in many cases becomes inoperable. But, since moisture is essential for mold development, investigators regard mold as merely an indicator of unhealthy moisture conditions, and moisture, of itself, as sufficient to cause all the damage. Conversely, it may be pointed out that these mold filaments are more than 90 percent water, with dissolved electrolyte, which could have a great effect upon an insulating surface.

One outstanding effort to segregate mold and moisture is being made by Dr. R. H. Luce and his associates at the Rensselaer Polytechnic Institute in collaboration with K. N. Mathes of the General Electric Company. Their method is to expose insulated wire specimens to mold and moisture in the humid atmospheres of closed glass vessels. Other specimens, similarly prepared are "fumigated" with a sterilizing gas which kills the mold present in the enclosed atmospheres. The gas is then swept out in a stream of sterile air and these specimens serve to demonstrate the influence of moisture only. One conclusion drawn from these experiments, states that only in materials of good moisture resistant properties is it possible to detect the influence of mold.

The experiments conducted at the Naval Research Laboratory tend to support the findings of Dr. Luce and his associates. Here two considerations were uppermost: Any sterilizing treatment that could conceivably alter the electrical characteristics of the sample was to be avoided and every factor (except living mold) that might degrade electrical properties had to be

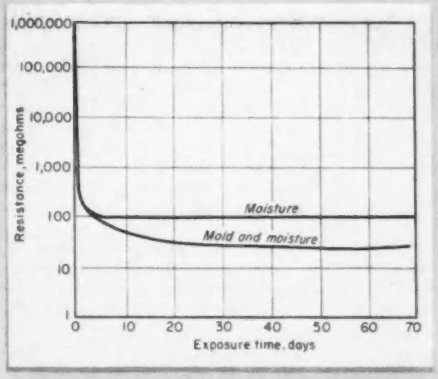


Fig. 3—Glass braided wire is so much less resistant to moisture that mold can scarcely degrade it more. Tests show that this reaction is typical of all insulation with poor moisture resistance.

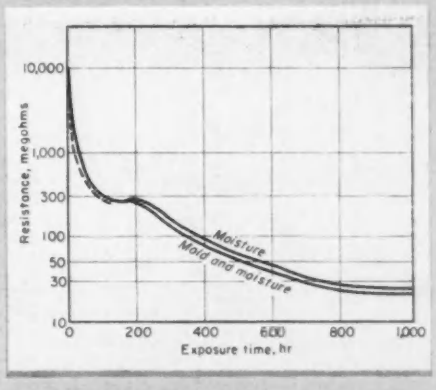


Fig. 4—Phenolic, Paper Laminated: The electrical qualities of paper laminated phenolic sheet material follow the same general performance characteristics under influence of mold growth as glass braided wire covering.

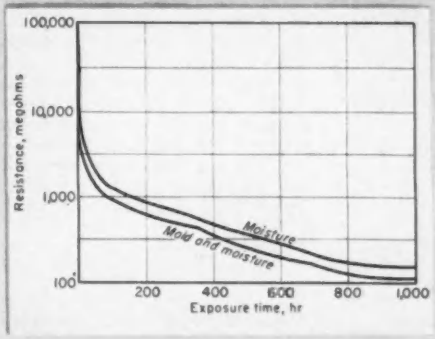


Fig. 5—The rapid drop-off in electrical resistance of wood floor phenolic sheet illustrates why such materials should be used only where circuits are not critical.

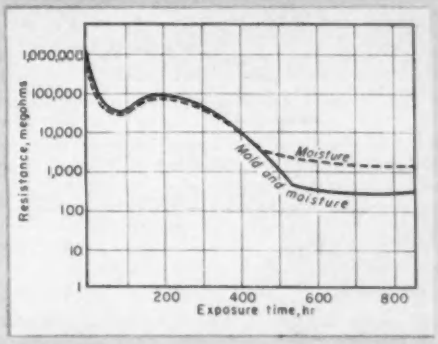


Fig 6—Loss in electrical resistivity of cast methyl methacrylate due to moisture and to moisture and mold. The two curves coincide until mold growth commences.

included in equal quantities to all samples.

Accordingly, a small quantity of wheat bran was moistened and inoculated with mold from several laboratory cultures. After the bran was thoroughly moldy, it was ground to pass a 100-mesh sieve in a Wiley mill. The moldy material was then divided into two portions. One portion only was steam sterilized to kill the mold and both portions were then dried to approximately the same moisture content. Various plastic wire specimens were cleansed, dried at a moderate temperature, and mounted in stoppered flasks. One lot of specimens was inoculated by adding a bit of the bran containing live mold to the flask and shaking until the specimens were thoroughly dusted. The rest of the specimens were treated similarly with the sterilized bran. A 92% humidity was maintained by adding a saturated solution of potassium nitrate to each flask. Measurements of the d-c "creepage" resistance were made on two types of hookup wire insulation, and four types of plastic sheet.

In Fig. 2 the excellent qualities of a vinylite type wire in the presence of moisture is evident from the upper curve. Under the influence of moisture only, resistance dropped quickly to something over 100,000 megohms and remained practically constant throughout the exposure period. In the presence of living mold however, resistance fell to 10 megohms in about a month. Glass braided wire, on the other hand, is much less resistant to moisture; under sterile conditions, it reached equilibrium value, a mere 100 megohms, but as shown in Fig. 3, with mold it dropped only slightly more.

With the various sheet insulating materials the picture is essentially the same. With the paper-laminated phenolic, Fig. 4, and with wood-flour phenolic, Fig. 5, there is little or no difference between the specimens bearing mold and those exposed to moisture only. With materials of better insulating characteristics, the influence of mold becomes more conspicuous. The two curves for methyl methacrylate, Fig. 6, are almost

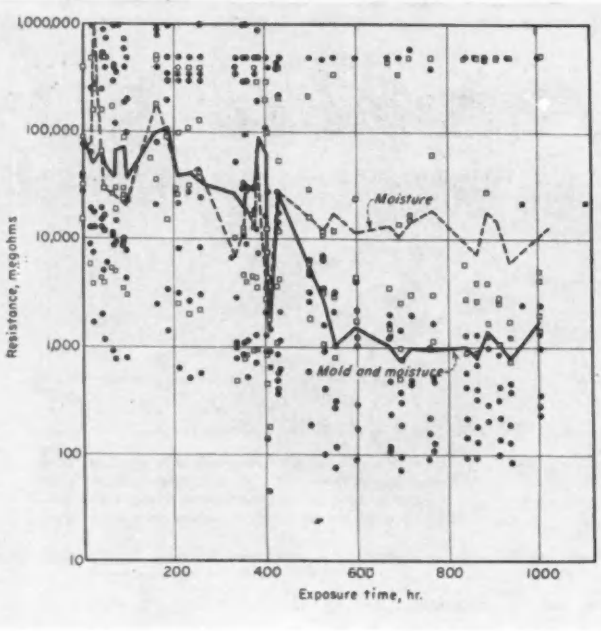


Fig. 7—Only on such a material as polystyrene is the influence of mold apparent.

identical for more than two weeks, coinciding, presumably, with a delay onset of mold growth. The specimens bearing live mold drop to about 300 megohms, while the sterile ones remain well above 1,000.

Polystyrene is an excellent insulating material from the standpoint of resistance to degradation by moisture. In these experiments, it showed a conspicuously erratic behaviour, Fig. 7. The lines follow the geometric means for each group of specimens. The sterile specimens show mean resistances in the range of 10,000 to 100,000 megohms; after about 400 hours, the mean of the samples with live mold is much lower. The difference would be even greater but for one recalcitrant specimen which remained at about 500,000 megohms, in spite of its mold. The difference, nonetheless, between moldy and non-moldy polystyrene is plainly evident.

In general, the following conclusions can be drawn from these tests: If the circuit requirements are not too critical, so that rather ordinary materials like wood-flour phenolic are adequate under moist conditions, fungus whether it grows or not, is unlikely to be a functional problem. If, on the other hand, extraordinarily high electrical resistances under moist conditions are sought, then the best material must be chosen, and due heed must be paid to what fungus may do to impair them. In terms of the polystyrene samples, this would mean that if the 100-1000 megohms of the moldy polystyrene is too low, and the 10,000 megohms of the sterile group is adequate, then fungus suppression deserves attention.

For the future, it is hoped to enlarge upon and to extend the observations and generalizations given here. But even in the future, as now, the final decision of what to do in a given instance, will be up to the design engineer. His purchaser can burden him with operational requirements and his colleagues can supply him with the performance characteristics of materials under various conditions. As data accumulates, as we propose it shall, we can promise only that his decisions will be easier.

A Little Boron Goes a Long Way

BORON STEEL—in which an ounce of boron may replace as much as 20 lb of critical alloying materials—is becoming a major tonnage product. Supplies of the standard alloying elements—nickel, molybdenum, manganese, and chromium—are scarcer now than during World War II because military products require increased output, better performance, and lighter weight. As a hardening agent, boron, in amounts less than a few thousandths of a per cent, can replace several hundred times its weight of manganese, chromium, molybdenum, and nickel. A boron-containing steel may be easier to process by machining, forging, or cold-working than the higher alloy steel which it replaces. The boron does not, however, impart better resistance to corrosion, wear or high temperatures for which many alloy steels are designed.

For applications involving heat-treated parts, boron added to steels with low or medium carbon content is a satisfactory replacement for some or all of the other standard alloying elements; in stronger, less ductile high-carbon steels the boron is unsatisfactory, and the scarcer alloying metals must be used.

The resistance of boron steel to fatigue failure, is probably the same as in other alloy steels of comparable hardness. In notch toughness—boron steel is adequate for most uses.

Some users feel that boron steels show more distortion during heat treatment than their equivalent steels. In spite of this, boron steels have been and can be successfully substituted for standard alloys. The substitution cannot be made blindly, but metallurgical knowledge must be applied if distortion is to be minimized. Modifications of carburizing and heat-treating procedures may be necessary in some cases.

Annealing time and costs are lower for boron steels than for the standard steels which they replace; scale formation is light and easily removed; die life for forged parts is increased substantially, and the steels are generally easier to process by either hot or cold working. At present the only bottleneck for increased use of boron, which is itself plentiful, is a limit on the production capacity available for making boron-containing alloying materials. Because only minute amounts of boron are required, it is not usually added alone to the steel, but is combined with silicon, aluminum, titanium, or some other alloying material, or even an inert carrier to distribute it throughout the steel. These mixtures are usually purchased by the steel company from another producer, and are added late in the steel process at the ladle, after the steel is drawn off and is ready to be cast into ingots.

Factors that Influence A Product's Appearance

CARL F. SCOTT
General Electric Company Bridgeport, Conn.

DESIGN IN THE SENSE OF APPEARANCE and styling has become an accepted step in the creation of manufactured consumer goods. Every engineer engaged in the automobile, domestic appliance and houseware industries, let alone many others that include a large part of the heavy machinery industry, is conscious of this phase of design and its importance in spelling the success of a product.

The engineer has to consider many appearance factors when laying out a new product or improving an existing assembly. In the case of consumer goods, these features can be grouped in five general categories: (1) contours, (2) finish, (3) color, (4) controls and hardware, and (5) fasteners.

Contours vary inherently according to the type and function of a product—a refrigerator, a shaver, a fan, a vacuum cleaner, a garbage disposal unit, each has its own general shape. But in each case, there are many possible variations of the basic contours so that common sense must play a leading role.

For approximately cylindrical objects, some should be a true cylinder, others a variation. A cylindrical hot-water tank should be straight-sided, but a vertical tank-type vacuum cleaner that is perfectly straight-sided and flat-topped would look more like a shipping container than a home appliance. Kitchen mixers at one time were plain cylinders with rounded ends. Now the longitudinal profile is bounded by curves, not straight lines. Surfaces, hitherto flat, today contain a slight bulge, as exemplified by electric toasters. The engineer is conscious of these trends, allows for them in his layout, is prepared to cooperate with the designer who works out the contours.

Though important appearance-wise, the finish of a product is essentially an engineering problem, independent of design. Take, for example, three common finishes: vitreous enamel baked on steel, organic enamel baked on steel and chrome-plated steel. A high-quality finish depends, in each case, on the kind of steel used, its processing before it leaves the steel-mill, its handling during fabrications, its cleaning before the finish is applied, the formulation of the finishing material, its application to the steel and its subsequent treatment (baking in the case of enamels, buffing in the case of electroplate). All of these are engineering problems, in which the appearance designer is interested, although seldom directly influential.

Color is much more an appearance consideration than an engineering factor. Considering only kitchen and laundry appliances, there are the other two important factors: One is the introduction of colors other than white; the other is the technical problem of matching different shades of white.

People are continually asking, when are we going to have color in ranges, refrigerators, washing machines and other major items for the kitchen and laundry? At the risk of over-simplification, it might be said that there is a struggle between the desire for white because of its sanitary association, and the desire for colors other than white for brightness and warmth. Currently, white is dominant, but walls, work surfaces and some cabinets have appeared in shades of cream, blue and red.

The problem of getting a good color match in the white finish of the various kitchen appliances is a serious one. Some are finished in porcelain enamel, some in organic enamels, some with both. Since the porcelain enamel is less flexible in color range, the practice is to adopt a shade of white for the porcelain enamel of an electric range, prepare panels of this color as reference standards and use these for matching the organic finishes applied to other appliances. Seldom will refrigerators, ranges, washing machines and dishwashers be made in the same factory, but a satisfactory assemblage of these different appliances will, in due course, be made in the consumer's kitchen and the colors must match.

Controls and hardware involve the engineer and appearance designer simultaneously. In the design and engineering of knobs and dials alone, a whole field is involved, and in hinges and latches, a whole industry. Knob engineering involves selection of material, impact strength, ease of molding, surface finish, ease of grasping and turning, location, visibility, first and assembly costs and many other factors.

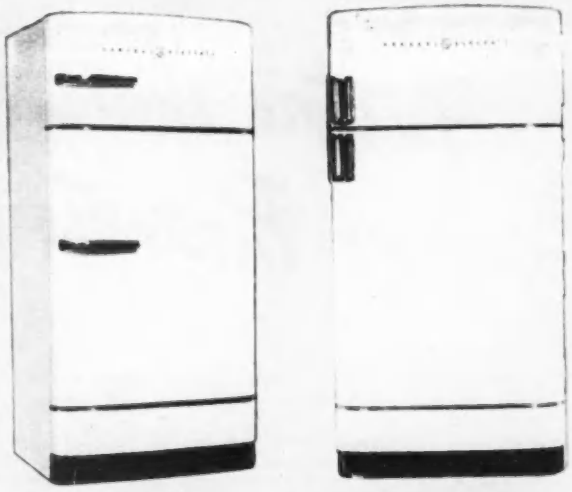
The engineer is conscious of the desirability of concealing bolt-heads and nuts. Where two housings were formerly held together by projecting flanges through which easily-reached bolts were fastened, today these housings mate without flanges, or with internal ones, and the bolts are recessed. At the same time, the engineer must keep servicemen in mind, by making nuts and bolt heads accessible.

To some extent, bolts and nuts have themselves been streamlined for better appearance. A fillister-head machine screw is regarded as more pleasing than a hex-head fastener, and a self-locking nut more attractive than a flat-head screw. To many engineers, chrome-plated, recessed-head screws are entirely satisfactory even though they are exposed. But some designers will take great pains to hide all exposed screw heads. Many ingenious snap-fasteners have been devised for this purpose. An example is the fabric-covered panel on the inside of automobile doors.

The case histories that follow illustrate how engineering and design aspects of a given product are weighed one against the other as they relate to the five appearance factors discussed above. (*continued on next page*)

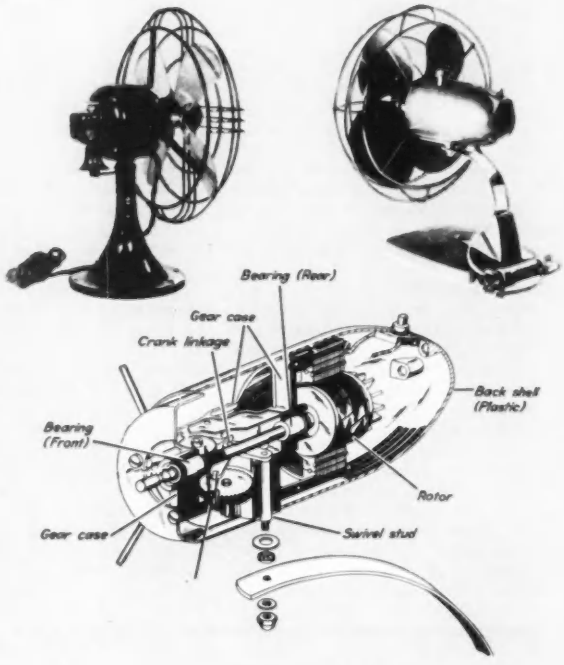
APPEARANCE FACTORS VITAL TO SUCCESS OF REDESIGNS

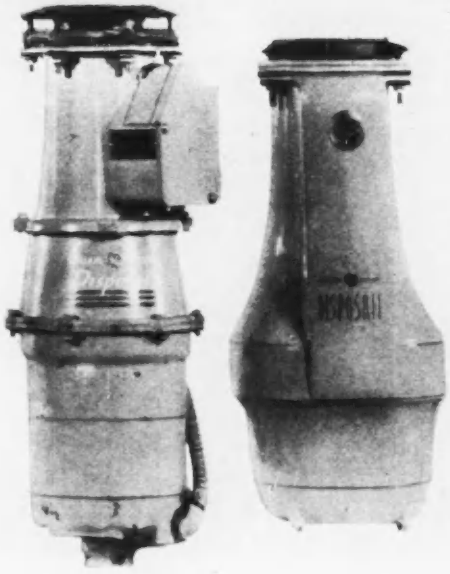
REFRIGERATOR CABINET. The development of the refrigerator cabinet with magnetic door gasket is a typical illustration of close cooperation between engineering and appearance design. During preliminary studies for the application of magnetic latches, it was decided that a concentrated pull on the door from one magnet located at the latching point was impractical. In the final design at right, the pull is distributed along the whole length of the extruded vinyl gasket on top, bottom and left side by a series of alnico magnets with like-poles abutting. Longitudinal flanges are provided for mounting and fitting the gasket into the door. Once the latch and strike (used in the earlier model at left) were eliminated, the handles could be greatly simplified, thus giving the designer free reign in evolving a more attractive unit. The handles were moved to the best position for user convenience—lower on the upper door and higher on the large door. The vertical handle gives a visual change in appearance, consistant with the new feature. The handle back plate protects the finish of the door, and with the chrome-plated horizontal beading, adds the necessary glitter to relieve the solid white of the doors. There being no latch, the release mechanism is now just a short vertical rod. Both of the models shown have individual letters in the manufacturer's name. This is more expressive than a single nameplate, which perhaps engineering would have selected for cost reasons, but appearance prevailed because of the distinctive character of separate letters. The top corners have a small radius which gives character to the overall appearance.

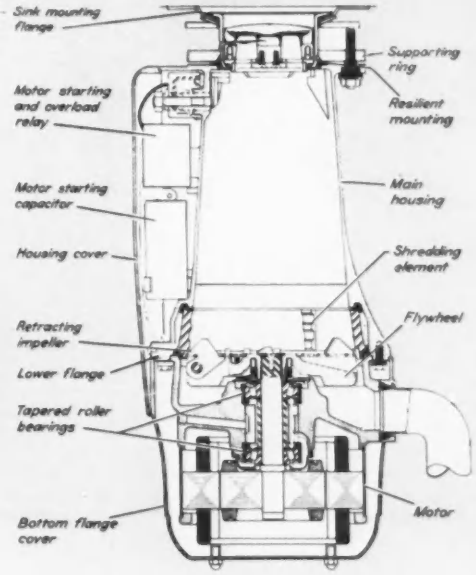


FAN MOTOR HOUSING. A new oscillating mechanism opened the way to a complete redesign of the conventional fan motor housing. The old model at left could have been modernized, but the oscillator crank still would have protruded. In the new model, the motor shaft is supported on two bearings with an interposed worm that drives a set of spur gears and a crank system. In this mechanism, nothing protrudes from the motor shell except the supporting stud about which the whole shell oscillates. A new magnetic circuit and redesigned punchings in the motor are other engineering changes. In the older motor with conventional magnetic circuit, size was determined by the need for keeping magnetic densities at a low level to reduce noise. A new circuit with redesigned punchings removed the noise factor at a size limitation. New motor has 33 percent more output than its predecessor, yet is much smaller in diameter, thus making possible a shell design that is not too large in diameter in relation to length.

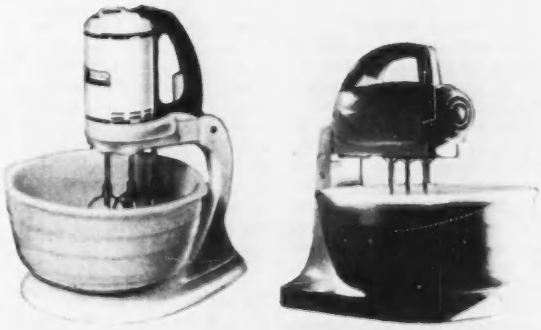
The maximum diameter of the shell is just back of the blade guard. Shell contour then follows an essentially elliptical path rearward to the rounded end. The on-off switch fits into a boss at the back of the shell. This break in the contour is a concession to the engineering need for providing space inside the shell for the switch body and leads. The oscillator control knob on top was originally designed with a straight knurl, but this was converted to ridges closed by a continuous bottom circle.







GARBAGE DISPOSAL UNIT. The post war model (left) of the Disposall, General Electric's garbage disposal unit, is actually the second redesign of the original 1933 assembly. Its contours are irregular and not as pleasing as those of the 1950 model at right. The sectional view of the latter illustrates the internal features that permitted design to use the contoured housing. The motor rotor is overhung on a twin roller bearing and needs no closure at the bottom. Thus the bottom flange cover has a contour that blends with the lines of the main housing. The lower flange, which carries the rotor roller bearing, is fastened to the main housing by cap screws (heads down). The thickness of the main housing required to accommodate these screws determines the maximum diameter of the whole assembly and thus the overall profile curve. The bottom flange cover conceals these cap screws giving a smooth overall appearance. While the heads of the screws holding the bottom flange cover to the motor stator could have been concealed, it was considered advisable to use the projecting acorn nuts which act as a four-point support for the appliance prior to installation. The bolts at the top, which hold the appliance under the sink, are not concealed, because they are out of sight, but still must be accessible. The motor starting relay and capacitor are concealed behind the separable die-cast housing cover, which has lines styled to blend with the main housing.



FOOD MIXER. In the redesign of this food mixer, the three beaters were retained, but the motor assembly changed from vertical (left) to horizontal (right). Engineering produced a motor of relatively small diameter and light weight with a compact governor and new control. Instead of using the flat cylindrical shape, which would be the shell shape of the lines of the motor only were followed, design made the top and side profiles curved. The flat area provided for the three beater mounting-holes is worked into the design by extending it back the full length and keeping it narrow. By introducing a step in the cross section on each side, the feeling of massiveness was reduced and space found for hidden cooling vents. To solve the problem of poor mating between the upper and lower shell pieces, a bead was added on the upper shell, thus giving character to the unit and hiding the joint. The "grilled" speed control knob, which blends into the diameter and contour of the shell, was placed up front to provide accessibility as well as an entrance for motor cooling air. Handle proportions and contours were worked out jointly by design and the home economists, and a gray color chosen for the handle, control knob and cord set. This color scheme gives the mixer head the appearance of reduced weight and is a pleasing departure from the hitherto conventional black handle attached to the cylindrical white head.

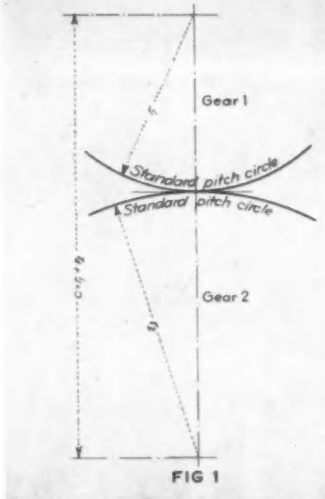


Fig. 1—Standard pitch circles and center distance for a pair of meshing gears.

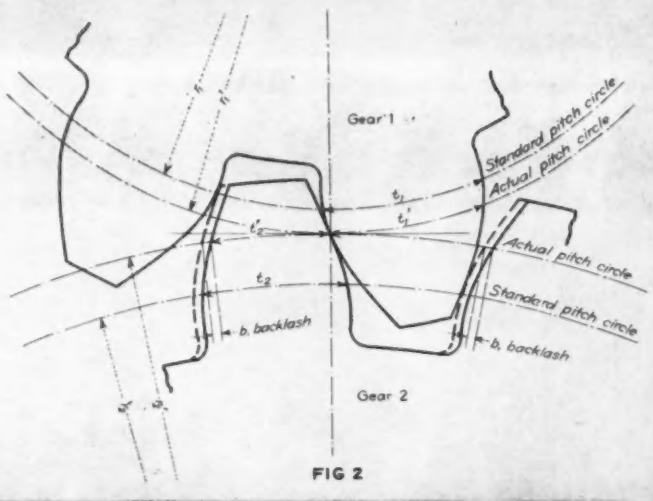


Fig. 2—Tooth thicknesses and pitch radii for two gears with backlash operating on pitch circles other than standard.

Control of Backlash in Gears

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TO PREVENT BINDING and to gain smooth tooth action in gear trains, clearance or backlash can be obtained by decreasing the standard tooth thickness, or by increasing the standard center distance, or by both methods.

When the gears carry uniform loads and always turn in the same direction, the amount of backlash usually has no effect on the operation of the train. When the direction of rotation of the gears in a power transmitting train is reversed during normal operation, an excessive amount of backlash may cause undesirable impact effects. In indexing mechanisms and other precision equipment, only a minimum amount of backlash can be tolerated because of the shift it introduces in relative angular positions upon reversal of the shafts.

In this discussion the nomenclature as defined in Table I will be used.

For two meshing gears, the relations shown in Fig. 1 are difficult to achieve since they imply that the gears have teeth of theoretically correct thickness and that the gears are mounted on a center distance that is also theoretically correct. When no consideration is given to backlash, the theoretical tooth thickness is half the circular pitch.

As actually cut, the tooth thicknesses t_1 and t_2 measured on their respective standard pitch circles may be greater or less than the theoretical tooth thickness. In Fig. 2, gears 1 and 2 are shown with tooth thicknesses t_1 and t_2 greater than the theoretical, and are operating on actual pitch circles of radii r'_1 and r'_2, and the actual center distance is

$$c' = r'_1 + r'_2 \qquad (2A)$$

The shift from the standard pitch circle to the actual pitch circle is such that the original gear ratio of the train is preserved, so that

$$\frac{r_1}{r_2} = \frac{r'_1}{r'_2} = \frac{N_1}{N_2} \qquad (3)$$

or from Eqs (2), (2A), and (3)

$$\frac{r_1}{r'_1} = \frac{r_2}{r'_2} = \frac{c}{c'} \qquad (4)$$

The sum of thicknesses t'_1 and t'_2 and backlash b on the actual pitch circles is the circumference of the actual pitch circle divided by the number of teeth in the gear, or

$$t'_1 + t'_2 + b = 2\pi r'_1/N_1 = 2\pi r'_2/N_2 \qquad (5)$$

To simplify the presentation, the relations existing between the base circles and the actual pressure angle for the gears of Fig. 2 are shown in Fig. 3. The gears, having been cut with a generating tool of pressure angle θ, have base circles of radii $r_1 \cos\theta$ and $r_2 \cos\theta$ respectively. These base circle radii remain unchanged regardless of the actual center distance dimension.

The actual pressure angle ϕ, at which the load is transmitted from one gear to the other, however, does depend on the center distance mounting dimension c'. The relationship between θ and ϕ is

$$\cos\varphi = \frac{r_1}{r'_1}\cos\theta = \frac{r_2}{r'_2}\cos\theta$$

$$= \frac{c}{c'}\cos\theta \qquad (6)$$

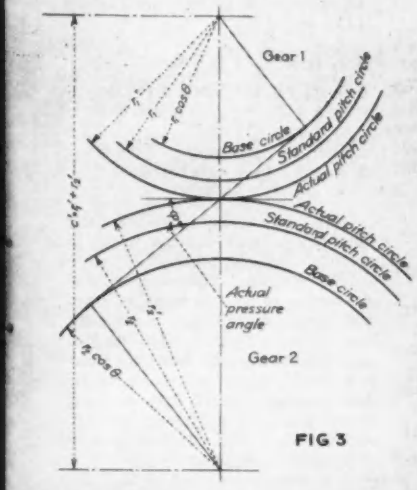


Fig. 3—Base circles and actual pressure angle for gears shown in Fig. 2, and actual center distance.

Table I—Nomenclature

SUBSCRIPTS:

Numeral 1 refers to gear 1; numeral 2 refers to gear 2.

SYMBOLS:

DP	= nominal diametral pitch	
N	= number of teeth in gear	
r	= radius of standard pitch circle = $N/2DP$	(1)
c	= standard center distance, in.	
	= $r_1 + r_2 = (N_1 + N_2)/2DP$	(2)
r'	= radius of actual or operating pitch circle, in.	
c'	= actual or operating center distance, in.	
	= $r'_1 + r'_2$	(2A)
t	= circular thickness of tooth measured at the standard pitch circle, in.	
t'	= circular tooth thickness on the actual or operating pitch circle, in.	
b	= backlash, in.	
	= $(2\pi r'_1/N_1) - (t'_1 + t'_2)$	
	= $(2\pi r'_2/N_2) - (t'_1 + t'_2)$	
θ	= pressure angle of generating tool, deg	
φ	= actual or operating pressure angle, deg	
inv θ	= involute function of θ = tan θ − θ (radians)	
inv φ	= involute function of φ = tan φ − φ (radians)	

by Dimensional Tolerances

Effect on backlash in mating gears caused by deviations from specified dimensions. Method of solving backlash problems when gears and center distance are individually selected for assembly. Procedure for calculating tooth thickness and center distance tolerances to obtain required backlash in selective assembly.

and the relationship between r_1, r'_1, t_1, t'_1, θ, and ϕ for gear 1 is

$$t'_1 = (r'_1/r_1)\, t_1 - 2r'_1\,(\text{inv}\,\varphi - \text{inv}\,\theta) \quad (7)$$

the corresponding equation for gear 2 is

$$t'_2 = (r'_2/r_2)\, t_2 - 2r'_2\,(\text{inv}\,\varphi - \text{inv}\,\theta) \quad (8)$$

An important relation is further obtained by adding Eqs (7) and (8), substituting Eqs (4) and (2A) into Eq (5), and substituting r_1/c for r'_1/c', and 1/DP for $2r_1/N_1$. This operation results in

$$\left(t_1 + t_2 + \frac{bc}{c'} - \frac{\pi}{\text{DP}}\right)\Big/2c = \text{inv}\,\varphi - \text{inv}\,\theta \quad (9)$$

The utility of Eq (9) is demonstrated in the solution of the following example.

EXAMPLE 1. Two 10 DP gears of 30 and 90 teeth, cut with a 20 deg generating tool, are to be mounted with 0.0010 in. backlash. After cutting, the 30 tooth gear is found to have a t_1 value of 0.1601 in. After boring, the center distance of the gear housing is found to be 6.0040 in. For the 90 tooth gear, find the value of t_2 necessary to maintain the specified backlash. From tables of involute functions

inv θ = inv 20 deg = 0.0149044

SOLUTION:—

By Eq (2) $c = (30 + 90)/(2 \times 10)$
$= 6.0000$ in.

By Eq (6) $\cos\varphi = 6.0000 \times 0.9396926/6.0040 = 0.9390665$
$\varphi = 20.1046$ deg $= 0.3508921$ radian
$\tan\varphi = 0.3660397$
inv $\varphi = 0.3660397 - 0.3508921$
$= 0.0151476$

By Eq (9) $t_2 = 2 \times 6\,(0.0151476 - 0.0149044) - 0.1601 - (0.001 \times 6/6.0040) + (3.1416/10)$
$= 0.15598$ or 0.1560 in.

The data given in Table II can be used to facilitate the solution of many gear problems. These data apply only to gears cut with a 20 deg generating tool. Using a series of empirical values of c'/c, this table was compiled to yield the numerical values of the related terms. In Table II

$$\Delta c = c' - c \quad (10)$$

and

$$\Delta t/2c = \text{inv}\,\varphi - \text{inv}\,\theta = [t_1 + t_2 + b\,(c/c') - (\pi/\text{DP})]/2c \quad (11)$$

Practical use can be made of the data in Table II by an approximate transformation of Eq (11). This trans-

formation is accomplished by substituting the terms $(c + \Delta c)$ for c'. The quantity c/c' in Eq (11) then becomes

$$\frac{c}{c'} = \frac{c}{c + \Delta c} = 1 - \Delta c/c + (\Delta c)^2/c - \ldots .$$

In gear problems the terms $(\Delta c)^2/c$ is ordinarily small enough to be neglected without introducing an error that affects the accuracy of any practical dimension. For practical purposes, therefore,

$$\frac{c}{c'} = \frac{c}{c + \Delta c} = 1 - (\Delta c/c) \qquad (12)$$

Putting Eq (12) in Eq (11) and dividing through by $2c$

$$\frac{\Delta t}{2c} = \frac{t_1 + t_2 + b - b\ (\Delta c/c) - (\pi/\mathrm{DP})}{2c} \qquad (13)$$

The utility of Table II is demonstrated by the following example.

EXAMPLE 2. Two 10 DP gears of 30 and 90 teeth, cut with a 20 deg generating tool, are to be mounted with backlash of 0.0010 in. The gears are already cut with t_1 for the 30 tooth gear measuring 0.1588 in., and t_2 for the 90 tooth gear measuring 0.1563 in. What must be the actual value of the mounting center distance?

SOLUTION:

$$c = \frac{30 + 90}{2 \times 10} = 6.0000 \text{ in.}$$

Using Eq (13)

$$\Delta t/2c = [0.1588 + 0.1563 + 0.0010 - 0.0010\ (\Delta c/c) - 0.31416]/2 \times 6 = 0.0001617 - 0.0000833\ (\Delta c/c)$$

Since its value is too small to affect practical considerations, the $\Delta c/c$ term and its multiplier in this calculation are neglected. Then by interpolating the $\Delta t/2c$ values in Table II, the value of c'/c is

$$c'/c = 1.0004 + 0.0001\ (158/365) = 1.000443$$
$$\text{or } c' = 1.000443 \times 6 = 6.0027 \text{ in.}$$

Thus, without finding ϕ, the solution is obtained.

For the value of c'/c given, inspection of Table II shows that the relationship between $\Delta c/c$ and $\Delta t/2c$, for 20 deg gears, can be closely approximated by the empirical equation

$$\Delta t/2c = 0.364\ (\Delta c/c)$$
$$\text{or } \Delta t = 0.728\ \Delta c \qquad (14)$$
$$\text{and } \Delta c = 1.374\ \Delta t \qquad (15)$$

Hence, these equations permit a variation Δc in center distance to be expressed in terms of Δt when the ratio c'/c is close to unity.

EXAMPLE 3. Work Example 1 by Eqs (14) and (15).

SOLUTION:

$$\Delta c = 6.0040 - 6.000 = 0.0040 \text{ in.}$$
$$\Delta t = 0.728\ \Delta c = 0.00291 \text{ in.}$$
$$t_1 = \Delta t - t_1 - b\ (c/c') + (\pi/\mathrm{DP}) = 0.00291 - 0.1601 - 0.0010 + 0.31416 = 0.15597 \text{ or } 0.1560 \text{ in.}$$

EXAMPLE 4. Work Example 2 by Eqs (14) and (15).

SOLUTION:

By Eq (11) $\Delta t = 0.1588 + 0.1563 + 0.0010 - 0.31416 = 0.00194$

By Eq (15) $\Delta c = 1.374 \times 0.00194 = 0.00267$ in.

By Eq (10) $c' = 6.0000 + 0.0027 = 6.0027$ in.

Thus by using Eqs (14) and (15) considerable time can be saved in solving many gear problems.

The foregoing equations indicate the method of solution when the gears and center distance are individually selected for each other. For random assembly, on the other hand, the backlash usually varies over wider limits. Equations will now be derived to aid the designer in dimensioning drawings and to indicate the extent of permissible backlash variation.

As previously indicated in Eq (12) the ratio c/c' can be approximated as equal to 1. Then by Eqs (10), (11) and (14), the backlash b is

$$b = (\pi/\mathrm{DP}) - (t_1 + t_2) + \Delta t = (\pi/\mathrm{DP}) - (t_1 + t_2) + 0.728\ (c' - c)$$

When the drawings are dimensioned with tooth thicknesses on the standard pitch circle equal to each other,

$$t_1 = t_2 = t$$
$$\text{and } b = (\pi/\mathrm{DP}) - 2t + 0.728\ (c' - c)$$

The maximum backlash occurs

Table II—Values of $\Delta t/2c$ for Different Values of c'/c

Note: Data are valid only for gears cut with a 20 deg generating tool. $\cos\theta = \cos 20 \text{ deg} = 0.9396926$

c'/c	$\Delta c/c$	$\frac{\cos\phi}{\cos\theta} = \frac{\cos\theta}{c'/c}$	ϕ, deg	ϕ, rad	tan ϕ	inv ϕ	$\Delta t/2c$
0.9990	−0.0010	0.940,6331	19.84183	0.346,3053	0.360,8471	0.014,5418	−0.0003625
0.9991	−0.0009	0.940,5391	19.85771	0.346,5824	0.361,1604	0.014,5780	−0.0003263
0.9992	−0.0008	0.940,4450	19.87357	0.346,8592	0.361,4733	0.014,6141	−0.0002902
0.9993	−0.0007	0.940,3508	19.88946	0.347,1366	0.361,7869	0.014,6503	−0.0002540
0.9994	−0.0006	0.940,2568	19.90527	0.347,4125	0.362,0990	0.014,6865	−0.0002178
0.9995	−0.0005	0.940,1627	19.92110	0.347,6888	0.362,4115	0.014,7227	−0.0001816
0.9996	−0.0004	0.940,0686	19.93693	0.347,9651	0.362,7241	0.014,7590	−0.0001453
0.9997	−0.0003	0.939,9746	19.95271	0.348,2405	0.363,0358	0.014,7953	−0.0001090
0.9998	−0.0002	0.939,8806	19.96848	0.348,5157	0.363,3474	0.014,8317	−0.0000726
0.9999	−0.0001	0.939,7866	19.98425	0.348,7910	0.363,6590	0.014,8680	−0.0000363
1.0000	0	0.939,6926	20.00000	0.349,0659	0.363,9702	0.014,9043	0
1.0001	0.0001	0.939,5986	20.01575	0.349,3407	0.364,2816	0.014,9409	0.0000366
1.0002	0.0002	0.939,5047	20.03146	0.349,6149	0.364,5922	0.014,9773	0.0000730
1.0003	0.0003	0.939,4107	20.04717	0.349,8891	0.364,9029	0.015,0138	0.0001095
1.0004	0.0004	0.939,3169	20.06285	0.350,1628	0.365,2130	0.015,0502	0.0001459
1.0005	0.0005	0.939,2230	20.07852	0.350,4363	0.365,5230	0.015,0867	0.0001824
1.0006	0.0006	0.939,1291	20.09418	0.350,7096	0.365,8329	0.015,1233	0.0002190
1.0007	0.0007	0.939,0353	20.10983	0.350,9827	0.366,1426	0.015,1599	0.0002556
1.0008	0.0008	0.938,9414	20.12547	0.351,2557	0.366,4522	0.015,1965	0.0002922
1.0009	0.0009	0.938,8476	20.14108	0.351,5282	0.366,7613	0.015,2331	0.0003288
1.0010	0.0010	0.938,7538	20.15668	0.351,8004	0.367,0702	0.015,2698	0.0003655

when the center distance is a maximum and the tooth thicknesses are a minimum. Then

$$b_{max} = (\pi/DP) - 2t_{min} + 0.728\,(c'_{max} - c) \quad (16)$$

The minimum backlash occurs when the center distance is a minimum and the tooth thicknesses have their maximum values.

$$b_{min} = (\pi/DP) - 2t_{max} + 0.728\,(c'_{min} - c) \quad (17)$$

The variation in backlash is then given by the difference between Eqs (16) and (17)

$$b_{max} - b_{min} = 2\,(t_{max} - t_{min}) + 0.728\,(c'_{max} - c'_{min}) \quad (18)$$

EXAMPLE 5. Suppose the circular thickness of 20 deg gears of 10 DP can be held to a total variation of 0.0013 in., and that the variation in the 6.0000 in. center distance is ±0.0010 in., and that for random assembly the minimum backlash is 0.0010 in. Find the value of the circular thickness to be placed on the drawings and the expected variation in the backlash.

SOLUTION:—

From Eq (17) $t_{max} = [(\pi/DP) - b_{min} + 0.728\,(c'_{min} - c)]/2$
$= [0.31416 - 0.00100 + 0.728\,(5.99900 - 6.00000)]/2$
$= 0.1562$ in.
$t_{min} = 0.1562 - 0.0013 = 0.1549$ in.

If the standard pitch circles have diameters of 3.0000 in. and 9.0000 in., the drawings should read "Circular thickness at 3.0000 in. dia of 0.1562/0.1549 in." and "Circular thickness at 9.000 in. dia of 0.1562/0.1549 in."

From Eq (18) $b_{max} - b_{min} = 2 \times 0.00130 + 0.728\,(6.0010 - 5.9990)$
$= 0.0041$ in.

Thus the expected variation in backlash is 0.0041 in., with a maximum value of 0.0051 inch.

When the tolerances on circular thickness and center distance are additive or arithmetic in the assembly, Eq (18) is valid. The simultaneous actual occurrence of the maximum and minimum values of tooth thickness and center distance as assumed in Eq (18) is exceedingly rare. In the majority of random assemblies, the minimum backlash will be larger than that given by Eq (17), and the maximum backlash will be less than that given by Eq (16).

High-Speed Crystal Clutch for Special Applications

AN EXPERIMENTAL crystal clutch recently developed at the National Bureau of Standards is believed to be the first of its type. In the new clutch, application of a direct-current voltage to the electrodes of three "Bimorph" piezoelectric crystal elements causes bending of the elements; this bending presses the clutch output disk against the rotating input disk. Distinguishing features of the clutch are high speed of response and almost negligible current drain. No current flows, other than insulation leakage, after the applied voltage has charged the capacity of the crystals. The clutch creates no magnetic field.

In the only model thus far constructed, the output shaft delivered useful torque in as little as 0.2 millisecond after voltage was applied. Output torque was approximately 16.5 oz-in. at 400v excitation, or 21 oz-in. for 500v. The no-voltage drag torque was about 7.5 oz-in.

Construction of the crystal clutch is essentially simple. The output disk is located between two rotating members; a thin, flexible crystal pressure plate and a heavier mounting plate or input disk. Three of the Bimorph crystal elements, which bend when opposite potentials are applied to different parts of the crystal surfaces, are spaced at 120-deg intervals. When the exciting voltage is applied, the crystals press against the pressure plate at a radius of 1.5 in., pinching the output disk between the plate and the input disk.

The clutch proper and its immediate mounting occupy a space about six inches in diameter and a little more than an inch long. The complete assembly includes, in addition, internal bearings for the output shaft, bearings and mounts for the entire assembly, a drive pulley, and slip rings for transmitting the exciting voltage to the rotating assembly.

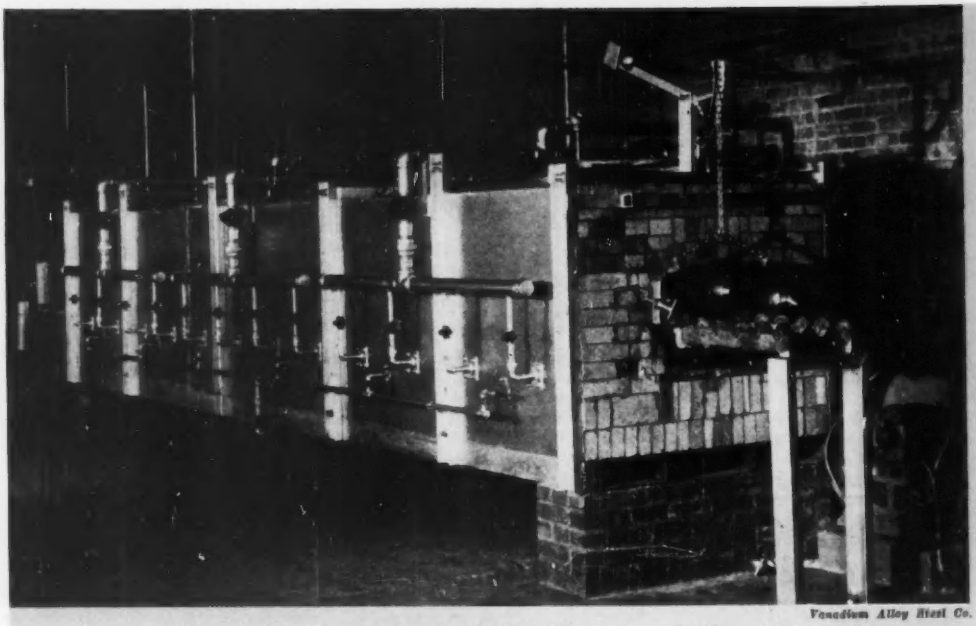
Several factors enter into the design of a clutch of this type. Speed of response, the principal design goal, is related to the inertia and loading of the output system, the available torque, the distance the crystal pressure point must move before it begins to pinch the output disk, and the resonant frequency of the crystal itself. It is the resonant frequency that sets the ultimate limit for speed of response.

The dimensions of the Bimorph crystal determine not only its resonant frequency but also its sensitivity. The resonant frequency, in kilocycles, of a Rochelle salt crystal Bimorph is given by 26 T/LW, and the sensitivity in mils per kilovolt is approximately 0.08 LW/T², where L, W, and T are crystal length, width, and thickness, in inches. Since increased crystal thickness is favorable to high resonant frequency but unfavorable to high sensitivity, design dimensions are matters of compromise and judgment.

If resistance is present in the excitation circuit, the voltage appearing across the crystals will rise exponentially while the crystal capacity (about 0.0065 uf) is charged. If the voltage rise is excessively slow, speed of response will of course be impaired. It might be thought that if resistance were eliminated, so as to give very fast voltage rise, speed of response would be a maximum. This does not prove to be the case, however. Instead, an irregular output motion appears, probably due to bouncing of the crystal against the output disk, while response time shows no significant improvement.

Rochelle-salt crystal elements are used in the present clutch because they are readily available and highly sensitive. Rochelle salt has several disadvantages, however: it is easily fractured, melts at 55 deg C, and will deliquesce unless protected from humidity. Barium titanate crystals, a logical alternative, should provide a mechanically rugged clutch usable at temperatures up to 100 deg C. Barium titanate is less sensitive than Rochelle salt, however, and also has a higher capacity.

Obviously, this crystal clutch does not have wide applicability. Yet its high speed and negligible current drain could be very valuable in a few highly specialized but nevertheless important instrumentation functions. In special photographic recording apparatus, for instance, the crystal clutch could be used to move motion picture film in fast response to an actuating voltage. The experimental clutch model could undoubtedly be improved upon; in fact, several desirable modifications have already become apparent.



Vanadium Alloy Steel Co.

Fig. 1—Continuous furnace for annealing and reducing stainless steel powder. The powder is made more compressible and practically free of oxides by this operation. Batch type furnaces are also used.

Stainless Steel

National Meter Division, Rockwell Mfg. Co.

Fig. 3—Powdered stainless steel parts. These parts are used in water and industrial meters. The bushings gave better resistance to wear and galling and were obtained at a lower cost than those made by other techniques. The sintered and coined driving arms have also performed satisfactorily because of their smooth surface, absence of burrs and good corrosion resistance. Tapping of the holes was the only machining required on these driving arms.

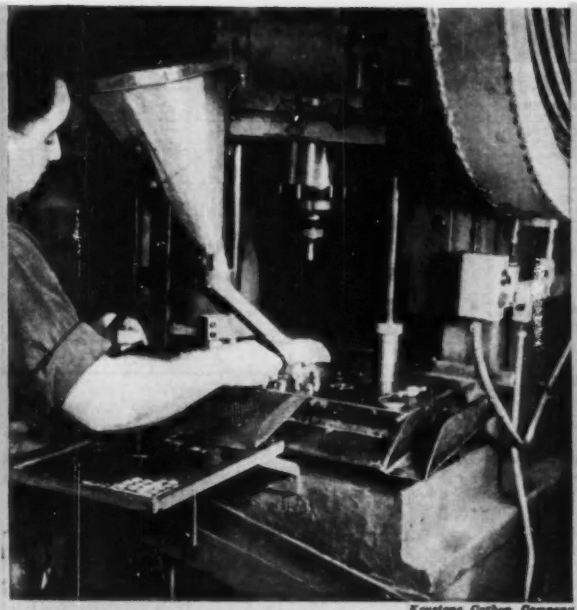
USE OF THE POWDER METALLURGY PROCESS for the production of small stainless steel mechanical parts has long been a goal of machine designers because:

(1) Production rate can be increased.
(2) Machining can be reduced or eliminated.
(3) Smooth, clean surfaces can be obtained.
(4) Close tolerances can be held.
(5) Properties are similar to wrought stainless steel.

Previous attempts to produce a good, workable austenitic stainless steel powder had resulted in several problems. Process limitations and poor corrosion resistance of finished parts had been the drawbacks.

However, a Type 316 stainless steel powder is now being produced that can be pressed and sintered at pressures and temperatures which are commercially feasible. Most of the shapes fabricated from other powdered metal materials can now be obtained in stainless steel.

The powder is produced by water-jet disintegration of



Keystone Carbon Company

Fig. 2—Powder is fed into the die cavity from a hopper. The green compacts are ejected after pressing and brushed aside by the feeder shoe.

TABLE I

(a) Powder Properties of Production Lot

Flow	25 to 50 sec/50 grams on Standard Hall flow meter
Sieve Analysis	+ 65 mesh—trace
	+100 mesh— 3.5%
	+150 mesh—23.6%
	+200 mesh—24.7%
	+325 mesh—22.2%
	−325 mesh—25.0%
Molding Pressure	30 to 50 tons/sq in.
Sintering Temp.	2100 F to 2400 F
Sintering Time	30 min to 2 hours
Coining Pressure	30 to 50 tons/sq in.

(b) Properties of Finished Parts (Production Lot)

Tensile Strength, psi	15,000 to 60,000
Elongation, percent in 1 in.	2 to 20
Yield point in compression, (psi for 0.2 percent offset)	20,000 to 55,000
Hardness (Rockwell "B")	15 to 65
Porosity, percent	25 to 15
Specific Gravity	5.9 to 6.7

Powder for Mechanical Parts

ARTHUR H. GROBE, VANADIUM ALLOYS STEEL COMPANY
RAYMOND HOFFMAN, KEYSTONE CARBON COMPANY

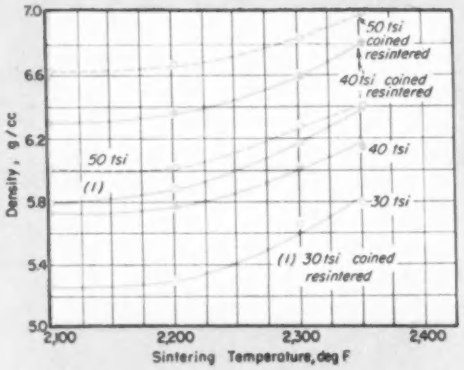
Stainless steel mechanical parts have been produced by the powder metallurgy process in the past but a new Type 316 powder gives promise of overcoming previous limitations and thus broadening the range of applications.

molten stainless steel with subsequent dewatering and screening. The shape and size of the powder particles can be effectively controlled by adjustment of the jet stream. Since the powder is produced directly from the molten alloy, with no intervening chemical treatment, the composition of the particles is identical with the composition of the melt. Compacts made from the powder are consequently uniform in properties if pressed and sintered under identical conditions.

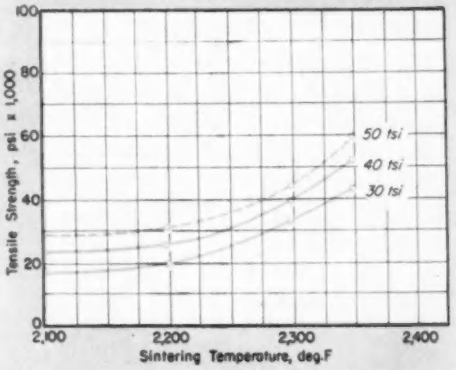
The shape o fthe Type 316 powder can be varied to obtain approximate spheroids with relatively smooth surfaces or irregularly shaped particles. For molding machine or functional parts a small amount of spheroids mixed with a larger amount of the irregularly shaped particles constitutes a good molding powder. A typical particle size distribution is shown in the sieve analysis included in Table I.

Because of the comparatively high molding pressures used and the higher friction of the stainless steel as compared to copper or iron, carbide die parts are necessary to produce good compacts, especially in large quantity. Lubricants used in pressing are those generally used in powder metallurgy molding and include stearic acid, stearates and waxes.

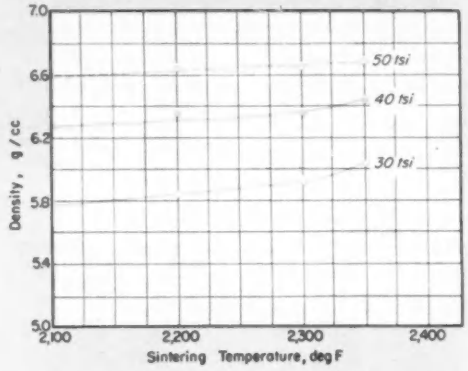
The sintering atmosphere must be highly reducing, and



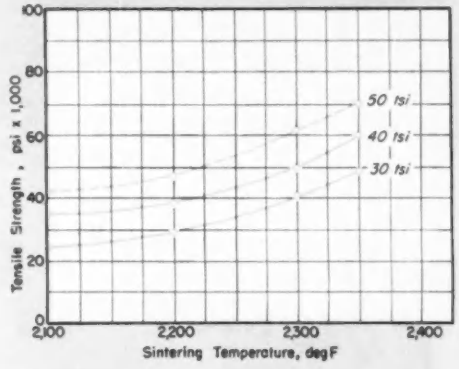
(a) Density vs Sintering Temperature for the —100 Mesh Stainless Steel Powder Type 316, P-738. Single sintering treatment and double sintering treatment with coining operation between sinters. All sintering was for 45 min.



(c) Tensile Strength vs Sintering Temperature for the —100 Mesh Stainless Steel Powder P-738. Single sintering treatments were conducted on these specimens. Sintering time was 45 minutes at temperature.



(b) Density vs Sintering Temperature for the —100 Mesh Stainless Steel Powder P-738. Single sintering treatment for 45 min. at temperature followed by a coining operation at the original compacting pressure.



(d) Tensile Strength vs Sintering Temperature for the —100 Mesh Powder P-738. Single sintering treatments for 45 min. at temperature followed by coining at the original compacting pressure.

the dew point very low. Precautions must be taken to prevent contamination or moisture pick-up by the atmosphere in the furnace.

Laboratory tests were conducted at the Vanadium Alloys Steel Company on the Type 316 powder. The purpose of the investigation was to determine the tensile properties, density and hardness of powder compacts from —100 mesh powder when compacted at 30 to 50 tons per sq in. and sintered for 45 minutes at 2,100 F to 2,350 F. The properties of the powder used are listed in Table II and the graphical results of the investigation in Fig. 4.

A metallographic study was made of three of the density compacts after the double sintering treatment and after the coining operation between sinters. The photomicrographs, Fig 5, show the structure obtained.

The conclusions reached as a result of this investigation are:

(1) The powder can be successfully sintered at temperatures as low as 2100 F with resultant tensile strengths for single sintering treatments from 17,000 to 29,000 psi and elongations of 5 to 6 percent.

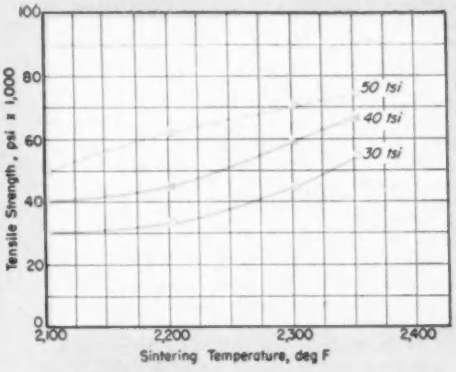
(2) The maximum tensile properties obtained by double sintering at 2350 F, with a coining operation between sinters, are 56,000 to 76,000 psi with elongations of 17 to 31 percent.

(3) The maximum weight loss in hydrogen was 0.29 percent after correcting for carbon loss.

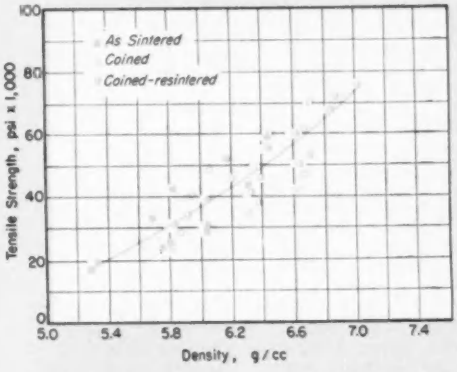
(4) A shrinkage of 1.2 to 1.5 percent was obtained by sintering for 45 minutes at 2275 F.

(5) Qualitative data on green strength led to the conclusion that a compacting pressure of 40 tons per sq inch would produce compacts that will withstand ordinary commercial abuse.

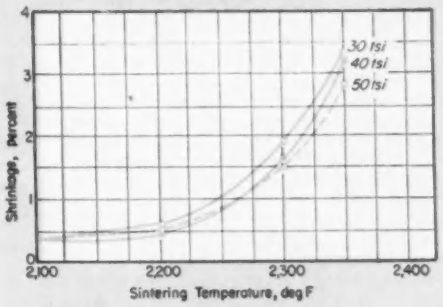
Since powdered stainless steel parts are sintered in a highly reducing atmosphere there exists the probability that they are in the active state and consequently more sus-



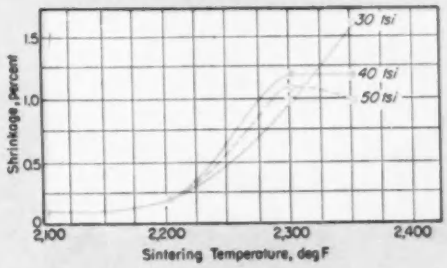
(e) Tensile Strength vs Sintering Temperature for the —100 Mesh Powder P-738. Double sintering treatments for 45 min. at temperature with a coining operation at the original compacting pressure between sinters.



(f) Tensile Strength vs Density for all of the Tensile Specimens made from the —100 Mesh Type 316 powder.



(g) Shrinkage vs Sintering Temperature for the —100 Mesh Stainless Steel Powder P-738. Shrinkage was measured on the 4 in. length of the tensile specimen. Single sintering treatment of 45 min. at temperature.



(h) Shrinkage vs Sintering Temperature for the —100 Mesh Powder P-738. Shrinkage for the second sintering treatment of 45 min. at temperature. Shrinkage was measured on the 4 in. length of the tensile specimen.

Fig. 4—Properties of Type 316 Powder.

ceptible to corrosion—especially in aqueous solution. Immersion of sintered parts in water for three months showed a slight amount of corrosion. However, after a short passivation treatment, parts immersed for the same period remained bright and unaffected.

Passivation procedures are quite simple. One effective method is to immerse the parts for 2 to 4 hr in a 10 to 20 percent solution of nitric acid, followed by a wash in running water. In some plants, passivation is resorted to for all stainless steel parts as an insurance against contamination by iron or steel particles.

Properties of Finished Parts

By varying compacting pressure, sintering temperature and coining pressure the physical and mechanical properties can be varied between certain limits. Table I (b) indicates the limiting properties obtainable in actual production. The lower values are satisfactory for bearings, either

Table II — Properties of Powder Investigated

1. Chemical Composition

Carbon	0.12%
Silicon	2.56
Manganese	0.61
Sulphur	0.007
Phosphorus	0.021
Chromium	17.00
Molybdenum	2.56
Nickel	11.32

2. Sieve Analysis

Mesh Size	Percent
+100	3.2
−100 +140	23.2
−140 +200	25.4
−200 +270	18.6
−270 +325	11.9
−325	17.7

3. Apparent Density — 2.62 g/cc

4. Flow Time — 28.7 sec

5. Compression Ratio

@ 30 tons/sq in.	1.99
@ 40 tons/sq in.	2.16
@ 50 tons/sq in.	2.27

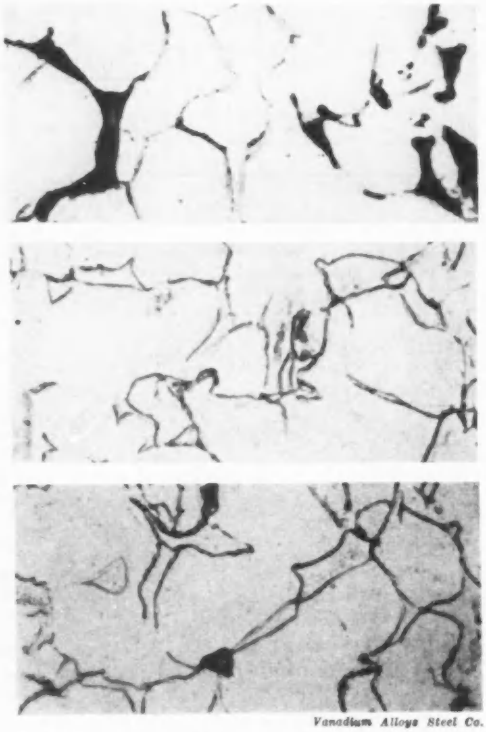
self-lubricated or not, that are subjected to light loads. For parts requiring higher strength and hardness the more dense product is preferable. Although the upper limit strength properties of the powdered parts are not as high as those of parts fabricated from cold rolled stock, they are sufficiently high for most general applications.

One outstanding property of powdered stainless steel is its resistance to wear and to seizing and galling. Cold rolled austenitic stainless steel parts frequently fail in service because of their tendency to weld together. The hardness or structural difference of mating parts can not be adjusted sufficiently to reduce wear and prevent seizing. In many cases a straight chromium martensitic type stainless has been used to run against an austenitic chrome nickel steel. However, corrosion resistance of the straight chromium type is not always satisfactory.

The powdered material can be varied in hardness and density over a wide range. Consequently parts of different hardness can be run together. Also, powdered parts can be run against non-powder parts to improve wearing qualities. Experience has indicated that powdered stainless steel is worth investigating by those whose problem with stainless has been poor wear resistance, or galling and seizing.

Rates of production of powdered stainless steel parts vary between 300 to 1000 pieces per hr depending on the size and shape of the part.

The shape and complexity of the part determine the tolerances that can be maintained. On most parts tolerances of ± 0.003 inch are general and ± 0.001 inch can be held if required.



Vanadium Alloys Steel Co.

Fig. 5—Photomicrographs of powdered stainless steel compacts after a double sintering treatment and coining operation between sinters. Specimen "A", sintered at 2250F has the regular single phase, stainless steel structure with some evidence of the original particle size and shape. The structure of specimen "B", sintered at 2300F shows some ferrite. Specimen "C", sintered at 2350F, also has some ferrite present and exhibits some signs of incipient melting. All specimens etched in mixed acid in glycerol. Magnification 500X.

Applications

Major application of these stainless steel parts in the mechanical field has been for small driving arms used in the intermediate gear trains of water meters. The water meter industry has shown considerable interest in powdered stainless steel because of the need for small parts which must operate satisfactorily for as long as 40 to 50 years. A material resistant to wear and corrosion by the various waters throughout the country is required. The Type 316 powder parts have properties suitable for such service.

Powdered stainless steel has also replaced cold drawn stainless tubing for sleeve bearings and bushings in some industrial meters that are used to measure nitric acid and other highly corrosive liquids. In this application, seizure of the 18-8 stainless shaft in the bushing of the same material resisted seizure and had better wearing qualities, attributable probably to its unique structure and lower density and hardness. The high cost and customer inconvenience involved in meter replacement was considerably reduced.

Other applications of stainless steel powder parts include guides for fishing rods, and a small cam in cigarette lighters. The relatively few current applications are a reflection of the newness of the process and the material and not its limitations. Small gears, cams, levers, bearings and other machine parts can readily be fabricated from Type 316 powder. The unique properties of the material and the attainable savings in fabrication cost are expected to stimulate interest among engineers and manufacturers.

The price of Type 316 powder is high, compared to bar or sheet stock—approximately twice as much per pound. However, the amount of material used per part is considerably less since there is negligible scrap loss and little if any required machining. The cost per finished part is usually competitive with parts fabricated by other processes.

The high cost of the powder is primarily due to the present low rate of powder production. The capacity of the powder plant is several times that of the fabricating industry that consumes the powder. The poor availability and high cost of good quality stainless steel scrap also contribute to the high price of the powder. Reduction in price can be expected as consumption of the powder increases and full advantage is taken of the production capacity.

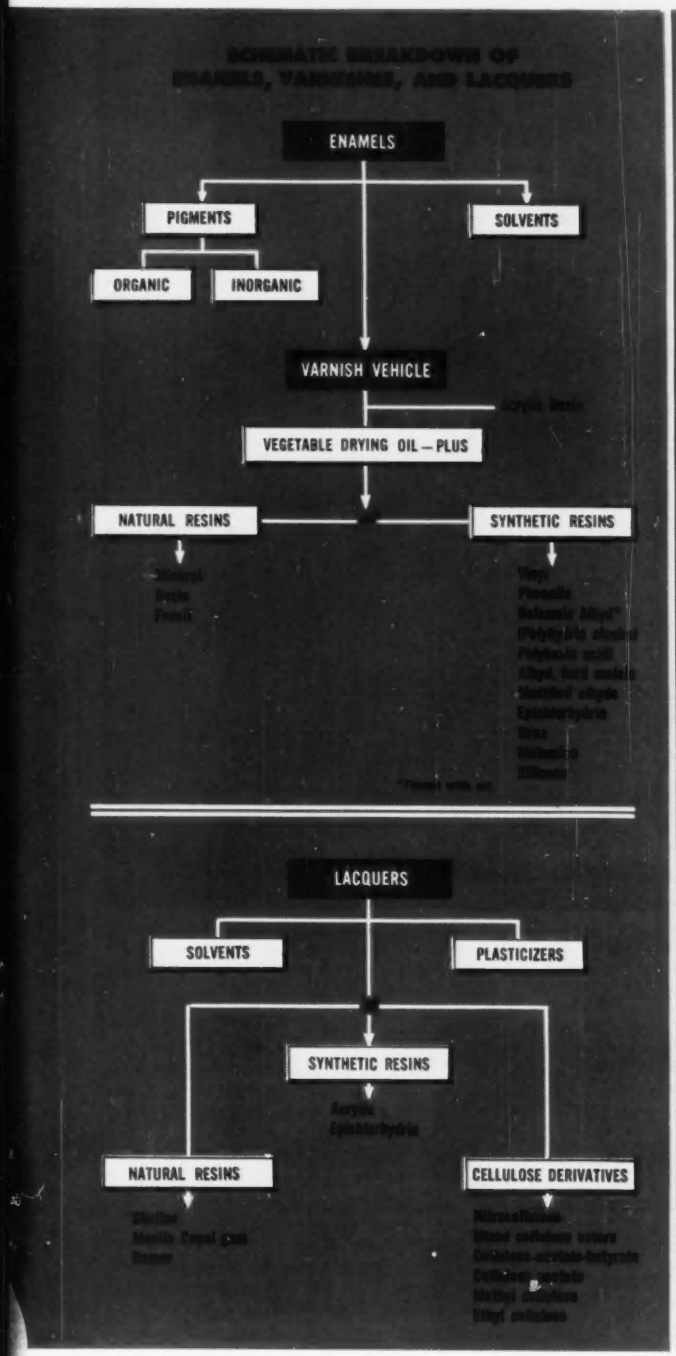
The initial cost of dies for pressing and coining is also high. Consequently the production quantity must be sufficiently large to absorb this cost.

Design Aspects

In the design of small structural parts such as cams, levers, gears and pinions the limitations of the powdered metal process and the processing properties of the powder must be considered.

The general design limitations for stainless steel parts conform with those for bronze or iron powder parts. These have been covered in previous articles and are well presented in the bulletins published by the metal powder companies.

Higher molding and coining pressures are required in forming Type 316 powder parts. The higher pressures decrease by approximately 50 percent the cross-sectional area that can be handled on a given capacity press as compared to bronze and iron parts. This is a limitation on the fabricator, and his press capacity will govern the size of the pieces obtainable.



Selecting Organic Coatings for Metal Products

Types of Finishes

Natural vs. Synthetic Bases

Long Term Trends

The Basis of Selection

Organic coatings are used on metal products for two main purposes, both of which usually go hand in hand: (1) to protect the surface of the metal, and (2) to improve the appearance of the products.

Of utmost importance in selecting a coating is the matching of the characteristics of the coating with functional requirements. The size of the surface to be coated, its engineering qualities, and the production facilities that are available in the manufacturing plant determine the method of application and of curing that can be used, and therefore are factors that affect the choice of coating.

Generally, organic coatings are

Finishing application on the Allis-Chalmers Model "CA" farm tractor. Finish used is a full-alkyd synthetic enamel. Tractors are sprayed first with a mist coat followed immediately by a full coat to give a total film thickness of 1.2-2.0 mils. Following spray painting, the tractors are baked in a forced convection type oven at 180 F. for 45 minutes.

classified as clear soluble or as pigmented materials. Or they can be classified according to their basic composition: oil or oleoresinous compounds, synthetic resin compounds, cellulose derivatives, and bituminous materials.

In accordance with the method of application, they can be grouped as brushing, spraying, dipping, or floating materials. In respect to the form of their cure, they can be typed as air-drying or as baking finishes.

The selection of any of these groups by the design engineer must be governed by the above and by

1. The type and condition of metal surface that is to be finished.

2. The ultimate requirement on the finished product in respect to appearance and to mechanical, chemical, and temperature resistance.

It is, of course, impossible even then to apply one coating to all products, since the size or shape or weight of the product also may affect the type that should be used.

Types of Organic Coatings

CLEAR SOLUBLE OR UNPIGMENTED MATERIALS can be varnishes, lacquers or bituminous coatings.

Varnishes are film-forming oleoresinous or synthetic resin compounds, such as alkyd or phenolic resins, that are diluted in volatile solvents. Depending upon the type of vehicle and solvent used, varnishes can be dried either by baking or air-drying (evaporation of the volatile thinner and oxidation and/or polymerization of the vehicle). Linseed oil and china wood oil are commonly used for varnish, along with the solvent.

The principal use of varnishes on metal is for such products as shipping containers for food and chemicals, and small hardware items such as hinges and rollers. Volume wise they are not as important for metal as some of the other types of

organic finishes. Their primary application is on wooden items such as furniture, but such uses are beyond the scope of this article.

Lacquers differ from varnishes not only in composition but in characteristics; for example, they dry by evaporation of the solvents in which the resin is dissolved. They are based either on cellulose derivatives like nitrocellulose, or cellulose acetate; mixed cellulose esters; methyl or ethyl cellulose; on certain natural resins such as shellac or manila copal gum; or on thermoplastic synthetic resins and poly vinyl compounds.

The amount and type of resin governs the gloss, adhesion properties, and other mechanical and physical properties of the finish (see Product Engineering, April 1951.) Plasticizers used with the resins add flexibility and adhesion.

Generally, they boil at high temperatures (e.g. tricreysl phosphate) and are solvents for celluloses, although non-solvent types such as bodied soya or linseed oils are also used.

Clear lacquers are used primarily as protective finishes for a previous coating or where the natural color of the metal is desired.

The third form of clear coatings—bituminous base materials—are solutions of natural asphalt (eventually in connection with oils) of petroleum asphalts and their modifications, or of coal tar derivatives. In either clear or pigmented form, they are used primarily for submerged service in sea water, for example, or for underground protection of metal surfaces.

PIGMENTED ORGANIC FINISHES are compositions based on inorganic or inorganic pigments milled with vegetable oils or resins and or any of the classes of clear varnishes which have been listed. When used in paints, these oils or varnishes are called vehicles or binders.

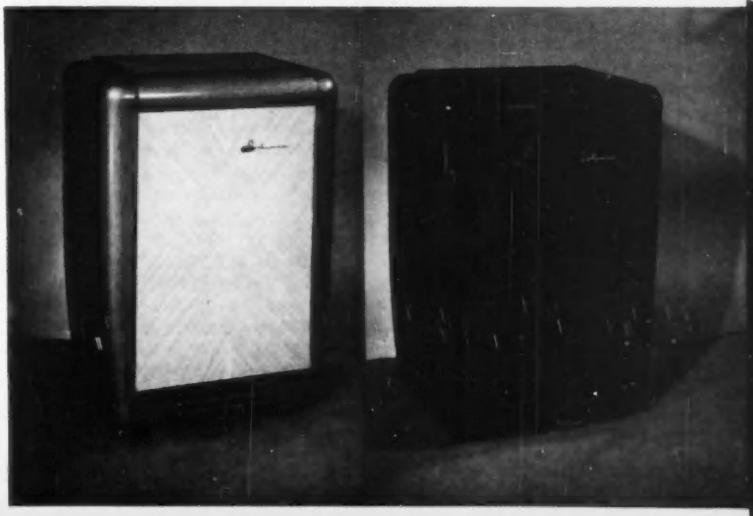
If this vehicle is largely a drying oil, this pigmented product is generally called a paint. As the content of resinous varnish vehicles or modified (heat-bodied) oils increases, the pigmented products are described as enamels. Pigmented bituminous coatings are not usually classified either as paints or enamels; in the same manner, pigmented lacquers are classified as such and not as enamels.

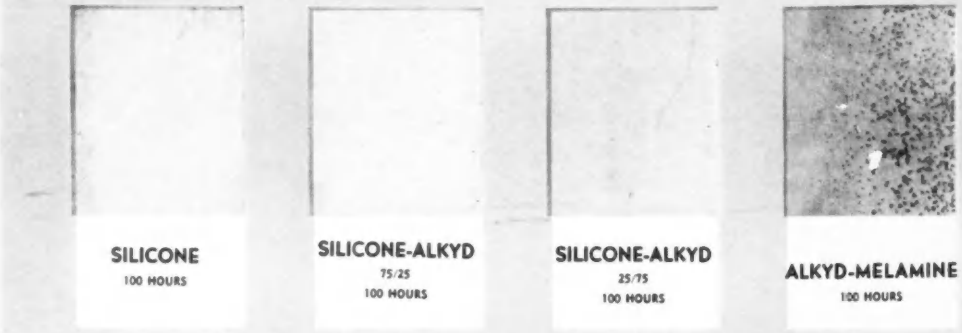
In enamels, there is currently a basic trend toward alkyd enamels. There are three reasons for this: One is that an alkyd base enamel is durable and has good adhesion on metal surfaces. Second, composition can be easily manipulated to obtain the desired characteristics. Finally, the color variations obtainable in alkyd base enamels are practically infinite in number, and the color retention properties are excellent.

Alkyd base enamels may be modified by urea or melamine to obtain hardness—although at some sacri-

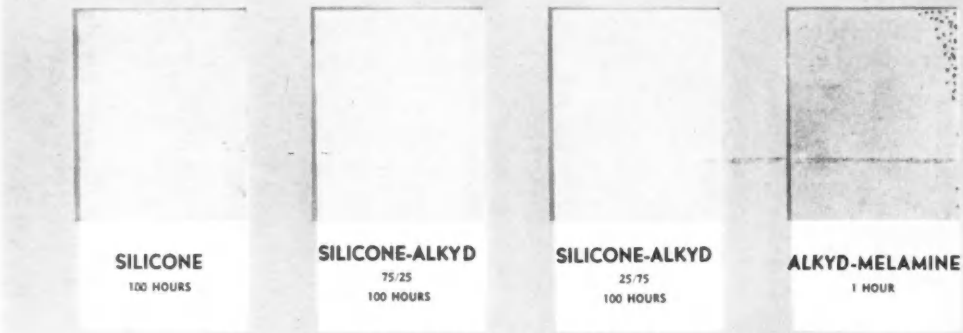
One of the newest applications of lacquers is for three-dimensional plastic nameplates and emblems made by molding a clear acrylic plastic and finishing it with lacquer in one or several colors on the back.

Good appearance and high temperature resistance are two of the salient requirements for the finish for these space heaters manufactured by the Coleman Stove Company. To obtain the grain structure on the panel, the unit is first cleaned and finished with an enamel base coat. The grain coat, which is an enamel and not an ink or decal, is then applied with a special roller and baked. Finally a clear coat is sprayed over the grain coat. The panel withstands temperatures of 300 F without discoloration.





How aging at elevated temperatures affects typical formulations of silicone, silicone-alkyd, and alkyd—melamine coatings at 392 F



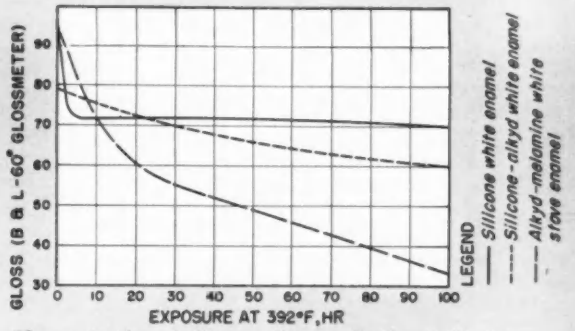
How aging at elevated temperatures affects typical formulations of silicone, silicone-alkyd, and alkyd—melamine coatings at 482 F

fice in adhesion and flexibility. A melamine-modified alkyd resin also can be used when improved properties at somewhat lower curing temperatures are desired. While melamine resins are more costly than urea resins, less are needed; since the baking temperature can be higher, the baking time is less and the cost may be lower.

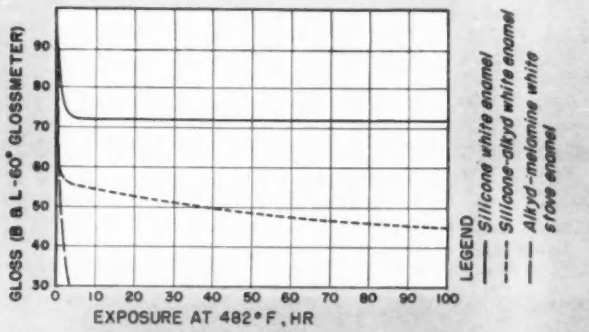
Silicone base enamels are coming fast. They were a late entry in the enamel field and volume wise today are not much of a factor. But within the next few years, they will become increasingly important as a coating for such products as industrial furnaces, motor housings and space heaters. Ordinary enamels as now used have definite temperature limitations, and there is a need for a low cost finish in light and pastel colors that will withstand temperatures of 400 to 500 F without discoloration. Silicone base enamels will usually fill this gap. The only finishes now available at popular prices are porcelain enamels.

The effect of using a silicone enamel on a product might be much greater than first examination would indicate. For example, one of the limitations on the surface temperature of a space heater is the temperature resistance of the coating. Too high a temperature causes discoloration and may result in blistering and peeling. Yet if the surface temperature could be increased, the size of the heater shell could be decreased or else the baffles eliminated. The use of silicone finishes has actually resulted in these design improvements.

An advantage sometimes not associated with the high temperature resistance of silicone enamels is faster baking time due to increased temperature of the ovens. For example, a product that requires baking for one-half hour at 300 F might be dried in a much shorter time if the temperature were raised to 425 F. Presently there are two restrictions to such a large increase in temperatures:



Gloss retention of silicone, silicone-alkyd, and alkyd-melamine white enamels at 392 F



Gloss retention of silicone, silicone-alkyd, and alkyd-melamine white enamels at 482 F

Data Courtesy Dow Corning Corp.

ordinary synthetic enamels yellow at these high temperatures, and the construction of most existing ovens makes raising the temperatures above 350 F difficult. Adding special catylists to enamels will also decrease drying time, but there is a point of diminishing returns in this respect. Silicones, of course, can be baked at temperatures as high as 450 F or above, and new oven installations definitely will provide for baking temperatures of 500 F.

Resistance to high temperatures is not the only desirable property of a silicone finish, however. Other properties, such as toughness, hardness, and acid and alkali resistance also are excellent. And while the substitution of a silicone enamel for a porcelain enamel finish on the top of a kitchen range is impractical now, it is a definite possibility in the future. Silicone enamels are being used experimentally on kitchen sinks and other household appliances subjected to high temperature and impact.

The other type of widely used organic finish having somewhat similar applications as enamels are the pigmented lacquer finish has an extremely high gloss if properly applied, and when polished, the film flows and evens out.

Besides a smooth finish, unusual effects can be obtained with lacquer. Many of the specialty finishes, such as crystal, crackle, veiled, pearl essence and opalescent finishes are modified lacquers. Spatter finishes, produced by spattering one color over another also are lacquer types.

Another advantage of lacquer is the speed with which it drys. Enamel usually must be baked, and the ovens or infra-red radiant heating installations are expensive. The drying time, which may range from 5 or 10 min up to an hour at temperatures of from 250 to 350 F, often is a deterrent factor in increasing production speed. Lacquers, being air drying finishes, require no such drying ovens. Furthermore, a lacquer finish can be spot-patched.

The disadvantage of lacquers is that, up to the present time, the cost per square foot of finished surface has been high. As a result, they have not been used in high production metal finishing operations to the same extent as enamels. As a matter of fact, the trend has been toward synthetic enamels; few large lacquer installations have been made in recent years.

The reason for the high cost is that a lacquer cannot be applied at too high solids and consequently more coats are required for a given film thickness obtained with synthetic enamels. There is a limit to the amount of resins and pigment that can be suspended in a solvent at spraying viscosity.

A recent development, the hot spraying process, may alleviate some of these difficulties. If the lacquer is heated before being pumped through the spray gun, the viscosity is decreased. This means that the initial viscosity can be much greater, and that greater amounts of resins—or less solvent—can be used per unit volume. Therefore, the thickness of the applied coating is greater, increasing from about 7/10 mils maximum for cold spraying to approximately 2.2 mils with hot spraying. Two hot spray coats therefore are sufficient whereas three were formerly required. Although the lacquer must still be polished, the operation is not so critical and overall costs are lower.

Insofar as quality is concerned, there is no difference between lacquer coats applied by the hot and cold methods. Other advantages,

besides those previously mentioned include less solvent waste, since there is less solvent per unit volume, and an increase in production without expansion of finishing facilities.

In general, lacquers are restricted in application to smooth surfaces, since contours or surface patterns make buffing difficult. One field of application that is increasing in importance is the finishing of plastics with clear or colored lacquers. So-called three-dimensional plastics are lacquered on the back, and many plastic radio cabinets are finished with a clear lacquer.

The trend in lacquer seems to be toward vinyls. While vinyl base materials are not being used in appreciable quantities at present, many finishers believe they have great potentialities. They are currently used for more or less special applications; cost is low, and they are fast and easy to apply, but surface adhesion is not too good. Current use is on hardware and inexpensive household equipment.

Selecting A Finish

In selecting an organic finish, cost, of course, is a salient factor, but other properties are usually more important, as previously pointed out. Briefly, the factors can be grouped under three headings; economic, application, and service. All are inter-related with one another, especially those under the economic classification, but they will be considered separately to better point up the significant considerations involved.

ECONOMIC FACTORS. The only true method of comparing the cost of a finish is by the cost per square foot of finished product. The cost per gallon of the enamel or lacquer may have little influence on this figure. Surface pretreatment required—grinding or buffing to remove surface defects, use of a surface treatment such as a phosphate coating, or the necessity of a primer to give suitable adhesion and provide a smoother finish—may be much more important. Baking schedule or drying schedule is one of the major factors affecting cost since, for an existing installation, it limits the number of units that can be finished per hour.

The hiding power of the finish also influences cost since it affects the number of coats that must be applied. There is a considerable amount of misunderstanding regarding this: hiding power is not a measure of covering power, but rather is determined by the wet film thickness and the opacity of the finish. Since the major problem in many products is due to surface imperfections in the base metal, the designer should get some measure of hiding power by actual trial run on the product that is to be finished.

Finally, the amount of reduction by solvents to obtain proper application viscosity, and the amount of buffing necessary to obtain high gloss are other factors that increase finishing cost. Buffing is not required in the case of enamels, of course, but lacquer finishes often are buffed, the cost depending on the number and extent of buffing operations, which in turn are governed by the number of coats necessary and the degree of gloss required.

SERVICE CONDITIONS. What is a primary service requirement for one application may be of no conse-

Finish used for a farm tractor such as this John Deere model must have excellent resistance to weathering. One of the various classes of enamels is the only logical choice—a modified alkyd enamel over an oleo-resin primer being widely used for this and automotive applications. See April 1951 issue for other details

Worthington Pump and Machinery Co.

A synthetic enamel is used on these Coca Cola dispensers. The hot spraying process, developed primarily for lacquer, is said to result in savings on synthetic enamels as well. Steam spraying of enamel is also being researched.

quence for another. As a result, no relative rating of the importance of one property of a finish over another can be made unless the application is known. However, the following listing contains the significant properties:

(1) Odor—In most applications, odor is not important. But in refrigerators, household appliances, and other food and chemical equipment, the retention of odor by a finish is undesirable. Vinyl coatings, for example, have good resistance to odor retention and thus are desirable from this standpoint.

(2) Dust Retention — Certain finishes pick up dirt. Urea formaldehyde resin-base coatings readily acquire a change of static electricity and thus attract oppositely charged dirt particles. While this may be a minor limitation, in certain applications it is a primary consideration.

(3) Cold Check Resistance—Resistance to temperature cycling without crazing or cracking is important for finishes on aircraft and aircraft components, refrigeration machinery and many other types of industrial equipment.

(4) Humidity Resistance—If a coating is pervious to moisture, it will blister and peel after limited exposure. This is followed by corrosion of the base metal. Testing for humidity resistance usually is done in a cabinet in which the temperature is held at about 110 F and the humidity at 100 percent. Blisters are measured according to ASTM Designation D-714-45.

(5) Color Retention—The color retention properties of a finish are measured by the fading (or yellowing if the finish is white) after exposure in an accelerated weathering machine. This property is important in all finishes.

(6) Abrasion Resistance—Abrasion resistant properties of a film are usually measured either by a Bell Abrasionmeter or by the Taber Abrazer. Hardness of film is not a measure of abrasion resistance; as a matter of fact, the harder and more brittle a film is, generally the less resistance it has to abrasion.

(7) Flexibility — This property is a measure of the ability of an organic film to flex or elongate when applied to flat sheet metal of uniform texture. It is determined by a bend test of a panel, the equipment and procedure being described in ASTM designation D-522–41.

(8) Impact Resistance—Testing of this property has been common practice in the paint and varnish industry for years, yet test methods have never been standardized. There is apt to be no uniformity between suppliers in reporting test results. Relative measurements are all that can be expected. However, from the standpoint of damage to the coating during shipment and service, impact resistance may be extremely important.

(9) Adhesion of Film—Good adhesion of film to the base metal is fundamental. In rating of properties, this is high on the list. The adhesive properties of any finish depend not only on its composition

RANDOM NOTES ON FINISHES

SOLVENTS add nothing to the final properties of an enamel or lacquer; they simply increase ease of application. That's one reason for developmental emphasis on hot spraying methods to increase the viscosity of coatings, cut down on the amount of solvents needed. Like buffing of electroplates, solvents are expensive and looked upon by most finishers as a "necessary evil."

Steam spraying of enamels for example is looked upon by many as the next significant development in finishing. Basically, it results in the same advantages as hot spraying of lacquer—greater solids per unit volume, better throwing power, and less waste. Many of the major paint manufacturers have research programs under way.

FLUORESCENT and phosphorescent paints have considerable practical application beyond novelty use on toys and lighting fixtures. Control valves, switches, and dials for naval vessels are finished with phosphorescent paint so they can be seen after power failure. Black light dials—painted with fluorescent materials to permit night adaptation of the eyes—are standard on aircraft. Of the phosphorescent materials, calcium sulphide gives a purple glow; zinc sulphide, a greenish yellow glow; and strontium sulphide, a bluish-white output.

EMULSION PAINTS have great military and civilian potential. Consisting mainly of an oleoresinous binder and suitable pigments, they are prepared by adding water to base paste. They provide a "flat" finish and have little odor—may prove important in the future for finishing metal surfaces.

METALLIC EFFECTS can be obtained by spraying and baking synthetic lacquer finishes over highly polished metal surfaces. Some television bevels are finished in this way. Advantage is not only greater availability of materials but lower material and production cost.

METALLIC PAINT, such as stainless steel, aluminum, and copper, are made by suspending finely divided metallic particles in a lacquer base. These are used primarily for surface protection.

LITHOGRAPHING is commonly thought of as a printing process utilizing colored inks. But lithographing of lacquers over baked enamel finishes is another way of obtaining decorative effects and special designs. In normal times, most fabricators that apply this method of finishing buy pre-enameled sheets.

SOME MANUFACTURERS are recommending modification of alkyd enamels by addition of styrene in special applications, the advantage being that styrene speeds up the drying time. A heavily styrenated alkyd coating however has less mar resistance than lightly modified or unmodified types.

THE GOVERNMENT is much interested in fireproof organic finishes, and considerable work has been done on finishes for wood. Also desirable are fireproof coatings for metal surfaces, such as interiors of ships and aircraft. So far as can be learned, not much is being done along this latter line, however.

FOR MILITARY USE, coatings with high infra-red reflectance are desirable to combat enemy photography of camouflaged equipment with infra-red film. This problem is being solved with a special additive.

ANTI-FOULING PAINTS for Navy vessels contain an ingredient such as copper flake, mercury oxide, or copper oxide. This prevents build up of barnacles and eliminates bringing ships to drydock frequently for scraping.

MOISTURE PROOFING and fungus proofing of electrical equipment is again a primary requirement for military products, just as during World War II. Only this time we're much further ahead, know what we need, and are using it.

but on the composition of the base metal, the surface pretreatment used, and the type of primer used. (While surface pretreatment is not a part of this article, its importance cannot be over-emphasized.)

Besides these, alkali resistance, water immersion resistance, stain resistance, and other service properties may be significant. While the number of these service conditions would seem to make impossible any practical rating of one finish against another, such is not the case. For one, there usually are only two or three outstanding properties required in any given coating, the others being of less significance. This usually narrows down the selection to two or three formulations of a specific type. Secondly, most manufacturers have established an arbitrary rating system for comparing finishes. The Nubian Paint Division of the Glidden Company, for example, has a point system by which a certain number of points are arbitrarily assigned for each property. The points for a specific property may vary from application to application, depending on the requirements. For the finish on the inside of a refrigerator, mar resistance and lack of odor would probably outweigh other properties. Thus, some indication of the relative ratings can readily be obtained.

OPERATING CONDITIONS. Finally, the operating conditions in the plant may also affect the selection of the finish, and in this respect, the designer is wise to rely on the judgment of the paint department operating supervisor. A partial listing of some of the factors follows:

1. The texture of the metal
2. The surface temperature of the metal
3. Humidity conditions in the spray room
4. Experience of operators
5. Method of application
6. Light conditions
7. Size and shape of part
8. Number of different types of parts
9. Temperature and cleanliness of the spray
10. Method of handling finished parts
11. How parts are assembled after finishing
12. Available oven equipment
13. Speed of conveyor
14. How fast temperature rises in the oven
15. Air velocity within the oven
16. Composition of air within the oven
17. Presence of hot or cold spots in the oven
18. Thermal head within the oven

In the Final Analysis . . .

Testing of lacquer, varnish or enamel should be done prior to using it on a product. If it does not meet service requirements, the manufacturer is in trouble since the coating may chip, peel, blister, discolor, or be affected in other ways. For specific formulations that have proven satisfactory under certain service conditions the designer can rely on information from manufacturers. Unfortunately, the test data from one manufacturer will not necessarily agree with those of another due to slight differences in method of panel preparation and test procedures. So long as the designer recognizes this fact and is conservative in his specification, he will obtain a suitable finish.

Industrial coatings, of course, are often custom made to meet certain requirements. The limitations can best be obtained by a discussion with the supplier.

ACKNOWLEDGMENT

Special thanks are due the Nubian Paint Division of the Glidden Company, Better Finishes and Coatings, Newark, N. J. and The Plaskon Division of Libby-Owen-Ford Corporation for certain data not previously credited.

TECHNICAL NEWS

NACA Reports Progress On Ram Jets and Guided Missiles

GREAT PROGRESS in the development of engines and controls for high speed aircraft and guided missiles has been made by the National Advisory Committee for Aeronautics, according to government scientists. These scientists reported on recent research projects at an inspection held at the Lewis Flight Propulsion Laboratory of NACA in Cleveland.

Fields in which significant advances have been made were listed as follows:

Icing: This problem has been intensified because the high speed of jet airplanes causes the interception of ice-forming cloud droplets at a rate many times the rate for conventional aircraft. Research has provided the key to possible reduction of the heat required for de-icing to one-tenth that used under present-day techniques.

Fuels: New fuels of higher heat content and improved combustion characteristics are "definitely to be looked for in the future."

Materials: New materials of superior strength and durability, capable of successful operation at the high temperatures generated in jet engines, and fabricated from raw materials plentiful in this country, are on their way.

Cooling: Techniques in this field, which will enable the thrust of turbojet and the power of turboprop engines to be more than doubled, have been brought to an advanced research stage, but further effort is required before they can be fully utilized in production engines.

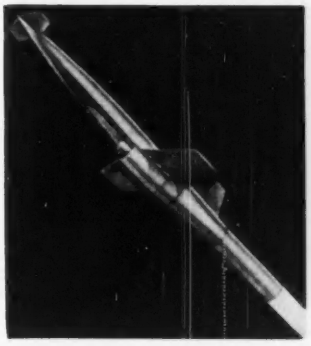
Afterburning: This device, when added to the tailpipe of the turbojet engine, "converts a normally subsonic propulsion device into one adequate for speeds of 1,500 mph." But much still remains to be done to increase economy and reliability of afterburners and to utilize most fully their potentialities for supersonic propulsion.

In the course of the inspection, visitors were shown how a full-scale ramjet engine for a supersonic guided missile, top, performed at 1,100 miles per hour.

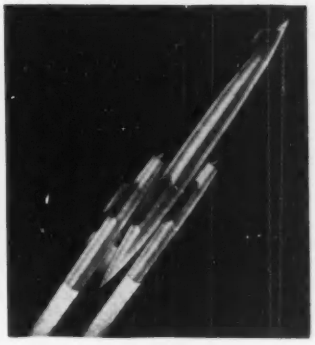
Underlining one of the major problems encountered in the operation of supersonic missiles, the wind tunnel test provided graphic proof of the need for highly-precise, split-second automatic fuel control, particularly during rapid maneuvering. As the fuel flow is increased to provide the additional thrust required for maneuvers, there is an increase in internal pressures, marked by drastic changes in the air flow pattern around the inlet, until a shock wave begins to move ahead of the inlet, finally reaches a point where it is oscillating violently. This pulsing can have serious consequences, either blowing out the engine's flame or, if severe enough, causing destruction of the engine and missile.

A number of other special problems associated with supersonic missiles and the search being conducted by NACA for information which will help designers in solving these problems were also discussed. On display were two large models of experimental missiles, (see below), which are being tested in the tunnel. One had two ram-jet power plants housed in nacelles on the wing. The other had its propulsion system enclosed within the fuselage and a protruding air inlet. Both incorporated the "canard" type of hori-

FULL-SCALE RAM-JET ENGINE for a guided missile in the 8- by 6-foot test section of a supersonic wind tunnel. Note the absence of distortion of the images reflected in the highly polished stainless steel walls of the tunnel.



RESEARCH MODEL of a guided missile which incorporates a ram-jet engine buried in the fuselage. The "tail first" design permits the horizontal control surfaces to be located on the nose instead of behind the wing.



EXPERIMENTAL MODEL of a supersonic guided missile which has twin ramjet power plants mounted in nacelles in the wing. The most efficient location of nacelles on missiles of this type is the subject of intensive research.

zontal controls, located ahead of the wing near the nose of the fuselage rather than at the tail, as in conventional piloted aircraft.

While this control system has distinct advantages in missile design, it also creates a new set of problems in connection with the location of missile power plants, as deflection of the control surfaces during maneuvers causes swirling disturbances in the uniform supersonic air flow behind it. Improper location of the air inlet can result in high engine losses.

Intermediate-Frequency Amplifier Has Miniature Components

A 7-TUBE MINIATURE INTERMEDIATE-FREQUENCY AMPLIFIER recently developed at the National Bureau of Standards embodies several innovations in electronic miniaturization technology. Particular emphasis is placed on the use of preassembled groups of similar circuit elements to simplify production. Designed to be hermetically sealed against contamination and moisture, the new amplifier uses components and materials capable of withstanding temperatures up to 200 C, found in compact sealed equipment.

The capacitor, resistor, and tube-shield subassemblies are fastened to the inductor subassembly comprising input and output transformers and six bifilar inductors fitted inside holes in eight ceramic blocks. The outer surfaces of the blocks are metallized by applying silver paint and firing. Besides providing electrical shielding for the inductors, this metallizing permits soldering the eight blocks to the chassis to make up the utilized subassembly.

The inductors are wound on tubular powdered iron cores having ferrite rods at their centers. Trimming is accomplished by sliding the rods in or out.

The preferred capacitor subassembly is of a new glass dielectric type. Seven groups of three capacitors (heater, plate-supply, and automatic-gain-control bypass) are encased in a single sealed and insulated glass unit. Common ground leads for each group of three are brought out from one edge of the unit, while the other leads extend through the opposite edge. This capacitor subassembly combines compactness with high dielectric strength and ample capacity (about 1,500 f per capacitor). Since the capacity-temperature coefficient and the losses are low, capacitors of this type could be used for tuned circuits as well as for certain bypass applications.

Wiring is simple and accessible. Since the layout makes possible extremely short connections, component leads are used exclusively. A high melting point solder of 95 percent tin and 5 percent silver was used throughout except for the case assembly; for this, a silver solder was used to give greater mechanical strength.

Many types of circuits could of course be adapted to some or all of the design features of the amplifier, and the circuitry used in the developmental model is not particularly significant. The first two tubes, comprising a low-noise input circuit, are triode connected and are followed by five tuned pentode stages. Overall bandwidth is about 3.5 mc with a center frequency of 30 mc, while gain is about 120 db. Input and output of the amplifier are transformer-coupled to coaxial cables.

Navy Develops Grease Tester for Large Slow Speed Bearings

AN ELECTRIC MOTOR GREASE TESTER has been developed by the Naval Engineering Experiment Station, Annapolis, Md., to test shipboard electric motor greases for large bearings operated at slow speeds under heavy loads. The apparatus consists of thirty individual test units mounted on two test stands, with controls and records centralized in a control panel. Each unit contains a separately driven test bearing in an individual oven with independent temperature control. Thrust and radial loads are applied by means of springs. The temperature of the test bearing is recorded and controlled from thermocouples by potentiometer instruments mounted on the control panel. The panel also contains electrical controls for the motors and heaters, motor ammeters and running-time meters, and provisions for readings motor wattage of any unit with a portable wattmeter.

The use of separate test units is a major improvement over other machines tested for control of test conditions and convenience of operation. The use of springs for loading provides a wide range of loads without numerous weights or levers, and the tester can accommodate several bearing sizes with the use of adapter bushings. This tester can handle bearings ranging in bore from 30 mm to 60 mm, and can provide radial loads up to 1,000 pounds.

Motor current is continuously indicated by an ammeter in the circuit, motor starters are grouped on the control panel instead of beside individual motors, and motor power can be recorded by plugging in a portable recording wattmeter. Redesign of the ovens and improvements in the temperature controllers bring the test bearing temperature control to ± 2 F.

Operation of the various testers at the Naval Engineering Experiment Station has shown that the majority of failures occur in starting after a shut down and cooling period. This is explained by the fact that frequently an oxidized grease will be sufficiently fluid for lubrication while at operating temperature, but at room temperature will be too hard to permit lubrication during the starting period. Hence, a daily shut-down will permit early detection of such a condition.

How GE Set Up A Materials Program

General Electric's move to meet the current materials' crisis consisted of the organization of existing personnel and facilities. When the problem became apparent, management set up committees to deal with it. The committees comprised purchasing and laboratory representatives.

As always, the need for a particular material starts with the product engineer. But these days, he hesitates before listing the material on a drawing. In most cases, he takes his material selection to a committee meeting for discussion.

The key members of the committee are the men from the purchasing department. The buyers advise the product engineers regarding the availability of the chosen material. Their advice is based on intensive knowledge of the entire materials' picture such as current and expected shortages, allocations, stockpiling, and priorities.

The third group represented in the committee is made up of laboratory personnel. Here again little departure from the established organization was involved. Each plant already had a "Works Laboratory" devoted to physical and chemical research. This research is mostly of the practical type—investigation of the characteristics of materials, finishes, processes and that might be applicable to G.E. products. Thus, when the buyers state that a wanted material is in short supply, the product engineer turns to the lab people for guidance on suitable substitutes. The aim of the materials committee is to select a material that: (1) has characteristics vouched for by the lab engineers as being a satisfactory replacement; (2) is declared to be in reasonably ample supply by the buyers; and, (3) is acceptable to the designer as being capable of doing the desired job.

These committees are set up on a plant-wide basis, rather than a company-wide basis. Meetings are called to assist in the design of new products, the redesign of an existing product and to decide on product changes that will be required by existing or anticipated materials shortages. In certain cases, a committee is set up solely to consider the materials' situation for one specific product. This is true, for example, of aircraft gas turbines, which at present require the use of many critically short materials.

The purchasing department is a source of accurate, up-to-date information on all aspects of the materials picture. The gathering of data is somewhat simplified by the fact that most buyers are specialized in one material—or at most a few. It is their everyday job to answer questions such as—"How much steel can we get for refrigerators six months from now? What priority will be assigned to copper for radar sets? Will foreign sources develop for cadmium?" The buyers use suppliers, government agencies, trade magazines and other sources as references.

An unusual facet of the purchasing department's function is the manner of dissemination of materials information. The buyers do not wait for committee meetings or specific engineering requests to pass along materials data. Instead, the Value Analysis Division of the Purchasing Department prepares and distributes three inter-company publications. These mimeographed periodicals includes "Value News," which highlights the problems with cartoons and a breezy style; "New Materials News", a monthly; and a bimonthly: "Buyers' Estimate of Materials Availability."

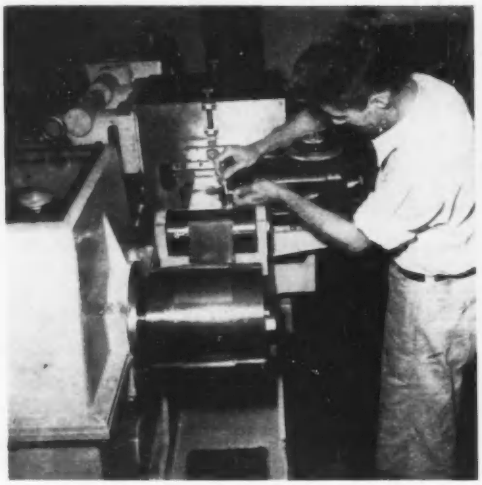
One-Man Helicopter for GI's

A ONE MAN HELICOPTER, weighing less than 100 lb and capable of transporting a soldier "plus armament" at a rate of climb never before held possible for helicopters has been revealed as one of the fantastic weapons forecast by President Truman.

Developed by Rotor-Craft Corp. of Glendale, Calif., the helicopter is powered by liquid fuel rockets, self-starting and throttle-controlled, which are mounted in the tips of two small rotor blades. The rotor is attached to a steel tube which curves downward to support fuel tanks, a pilot's seat and cargo hook. A tube extending backward from the rotor hub carries a small rudder, and another extending forward and down is the pilot's control column.

The machine is known as the "Pinwheel", and has been developed for Office of Naval Research. Ground tests were begun recently at a military base in the Los Angeles area. How fast and how high it will fly, and other details of design are classified information. It is claimed, however, that the "Pinwheel" packs more power, for the load it carries, than any helicopter ever built. Its rocket motors display no flame, and in approaching an enemy location at night it would be next to impossible to spot.

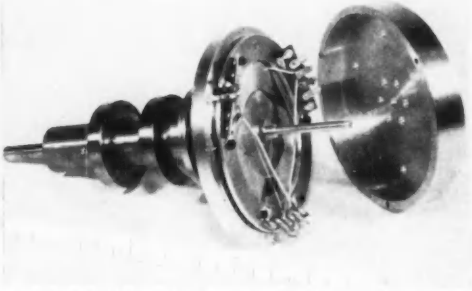
LATEST ADDITION TO THE FIELD OF MILITARY WEAPONS is this one-man midget helicopter, weighing less than 100 pounds, which has been developed for Office of Naval Research by Rotor-Craft Corp. of Glendale, California.



A SENDZIMIR COLD ROLL MILL, which produces extra-thin tapes used in pulse transformers, magnetic amplifiers, radar equipment and other high frequency operations is now operating at the Naval Ordnance Laboratory, Whiteoak, Maryland. The mill, capable of rolling metals to a thinness of a few tenths of a thousandth of an inch, was built at a cost of $75,000. It was installed last spring. Control adjustments are now finished.

THIS GIANT SIZE HEXAGONAL UNIT, 24 in. in thickness, is being produced for a 250 ton hydraulic press by General American Transportation Company. The cutting process is accomplished with an Oxweld cutting blowpipe made by Union Carbide and Carbon Corp. After the cutting operation, which is done at the rate of 3 in. per min, the units are threaded for column bolts. No other machining is necessary.

ENGINEERS IN THE ARMY QUARTERMASTER CORPS believe that the boiler in their new mobile shower unit for front-line troops can heat more hot water, faster than any unit of its weight and size in the world. The boiler can supply as much as 2½ million BTU per hr when operating on any liquid fuel from No. 4 oil to 100 Octone gasoline.



EXPERIMENTAL CRYSTAL CLUTCH developed by scientists at the National Bureau of Standards for certain specialized instrument applications. Characterized by high speed of response and negligible current drain, the clutch consists of three Bimorph crystal elements that bend when a d-c voltage is applied. Speed of response is about 0.2 millisecond.

ELECTRIC GAGES have been fitted inside a number of blades and connected to a radio transmitter to obtain details of the stresses to which the blades of Rolls Royce gas turbines are subjected while in actual flight. Readings of the gages are received at a ground station and stored by means of a magnetic tape recorder. The test pilot can also make comments and these are recorded on the tape at the same time.

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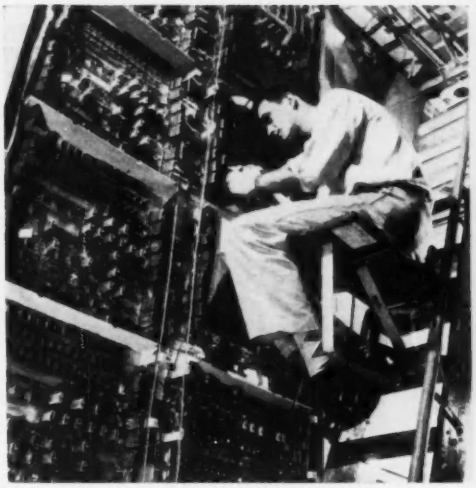
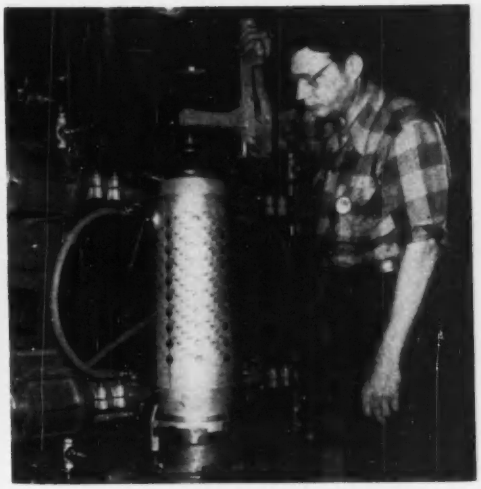
THOUSAND-CURIE SOURCES OF GAMMA RADIATION will be made available by the U. S. Atomic Energy Commission and Brookhaven National Laboratory to assist industrial organizations in studies of the applications of radiation to industrial processes. The thousand-curie sources, made of cobalt-60 or tantalum-182, each release as much gamma radiation as does 2.2 pounds of radium (an amount equal to the pre-World War II total world supply). Two such sources, one cobalt and the other tantalum, have been pre-

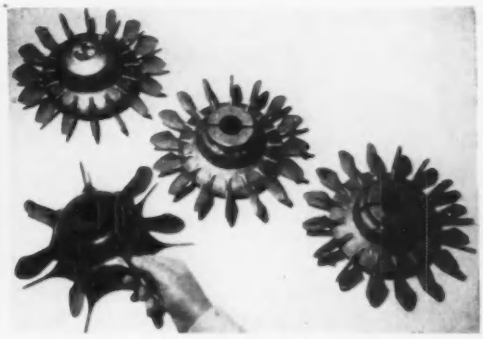


INSTALLER MAKING MODIFICATIONS in the Englewood Central switchboard of the New Jersey Bell Telephone Company to permit customers to dial straight through to telephones across the nation. A country wide numbering plan which includes part of Canada consists of 80 numbering plan areas, each of which is assigned a special three digit code. On a call to a seven digit number, ten numbers must be dialed.



ONE OF THE MOST SPECIALIZED WELDING MACHINES ever devised has recently been installed at Ryan Aeronautical Company for use in production of jet engine components. Designed by the Thomson Welding Machine Company, serves as both an assembly and fabrication machine in the manufacture of inner combustion chambers for the General Electric J-47 jet engine. It aligns and spot welds three parts.

THE GENERAL ELECTRIC COMPANY'S Chemical Division has developed this radio housing design, which has, as its basic module, a simple rectangular case. It can, with a change of dial knobs, speaker panel, or other extraneous parts, assume the appearance of several diverse styles. The module design can be used either horizontally or vertically.



PLASTIC BLOWERS molded of a polyester resin reinforced with glass fibers is being used by Westinghouse to replace critical aluminum and bronze in small, totally enclosed, fan-cooled a-c motors in NEMA frames 254 and 284. Glass fiber reinforcements have been found superior to organic fiber because of its higher resistance to chemical attack and higher strength.

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pared in the Brookhaven National Laboratory nuclear reactor. Additional thousand-curie sources will be made as needed.

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THE AMERICAN STANDARDS ASSOCIATION Subcommittee Y10.2 (formerly Z10.2), Letter Symbols for Hydraulics, has recently been reconstituted for the purpose of reviewing and revising the 1942 Standards on Letter Symbols for Hydraulics. The committee would appreciate receiving comments from interested parties concerning the 1942 Standards and any suggested additions or modifications thereof. It has been tentatively decided to consider the field of hydraulics as being concerned with all phases of the motion of liquids. An attempt will be made to include symbols in the field of hydrology and water-hammer. Suggestions and comments should be directed to the Chairman, Dr. J. M. Robertson, P. O. Box 30, State College, Pennsylvania.

HIGH-SPEED ALL-ELECTRONIC COMPUTER for general office and industrial use developed under contract for the Bureau of Ordnance, Department of the Navy.

Computer for Control in Process Industries

A STEP IN THE DIRECTION OF more sensitive instrumentation and control for process industries has been made with the development of a high-speed digital computing machine that is said to be the smallest electronic computer in existence.

About the size of a table model television set and weighing only about 100 lb, the unit can add two 24-digit numbers in eight millionths of a second. Two uses are visualized by the Jacobs Instrument Company, who developed the device: One is its use as an inexpensive computing machine for general office work; the second is its application for process control in industrial plants.

The machine can continuously measure temperatures, pressures, viscosities, or quantities of material in stock bins; perform complicated computations involving these quantities; and then adjust valves or motor controls to the settings necessary for maximum production. If materials run low, the machines can automatically control the ordering of new materials.

Known as JAINCOMP-B, the computers are designed not only to accept input data in the conventional ways used in computing machines, but also to accept inputs from measuring instruments.

The computer operates with binary arithmetic, and has binary inputs and outputs. Inputs and outputs can be set up in decimal forms, and the computer itself can perform the decimal-to-binary and binary-to-decimal conversion at the input and outputs.

All plug-in sub-assemblies, junction points and cables can be reached instantaneously for servicing, without the removal of any screws.

Germanium diodes are used extensively throughout JAINCOMP-B. However, because of the tendency of such devices to change characteristics, their use has been limited to non-critical applications, and their employment as computing elements has been avoided because of the reliability of the tube circuits used in this computer.

ML Aluminum Alloy Has DoubleTemperature Range

A NEW LIGHT METAL CASTING MATERIAL, ML Aluminum Alloy, has been developed by the Air Force for use in elevated temperature operation. Castings, supports, and many other parts that formerly could withstand only 200-300 F can now be designed for temperatures of 500-600 F.

ML aluminum, which includes small percentages of copper, nickel, magnesium, manganese, chromium, vanadium and titanium as alloying elements can support a load of 6,600 psi for 1,000 hours at 600 degrees. Its maximum tensile strength is 17,300 psi at this temperature. Tensile strength is 33,000 psi at room temperature.

A COMPREHENSIVE STUDY OF the effects of chromium plating on SAE 4130 steel made by the National Bureau of Standards included tensile, tensile impact, bending and crushing tests. Results are available from the Bureau in Technical Report 1546.

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A 250,000 HP WIND TUNNEL, said to be the most powerful ever built and capable of creating supersonic blasts of air, is being constructed for the Lewis Flight Propulsion Laboratory of NACA by General Electric. The drive will consist of four 37,500 hp and three 33,334 hp variable speed a-c induction motors linked with two axial flow compressors. Four of the motors will be mounted in tandem on a single shaft operating one compressor, while the remaining three will operate the second compressor. Peak wind velocities will be obtained by operating the compressors in tandem. The individual motors, among the largest of their kind, will be approximately 14 ft high, 14 ft wide, and 25 ft long, and will weigh about 120 tons.

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COOLING OF LARGE GENERATORS by blowing hydrogen gas through specially built hollow generator coils to bring the cooling medium in direct contact with the copper in which the heat is generated will make it possible to increase generator ratings by as much as one half, according to engineers of Westinghouse Electric Corporation. Internal, rather than conventional hydrogen cooling, is said to be particularly adaptable to units for ratings of 90,000 kw and above.

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THE STATE-OWNED PARIS SUBWAY SYSTEM is building an experimental pneumatic-tired train that its engineers predict will combine greater passenger comfort with improved operating efficiency. The rubber-tired train will not require rails but will run in a simple concrete channel. It will be equipped with guide wheels turning in a horizontal plane against the side walls of the channel to hold the car in the center of the way. In addition to the obvious improvement in passenger comfort from reduction of vibration and noise, engineers believe a train riding on rubber may achieve considerable savings in operating costs by eliminating present charges for rail maintenance and by power savings due to its lighter construction and to its more efficient use of power in starting and stopping.

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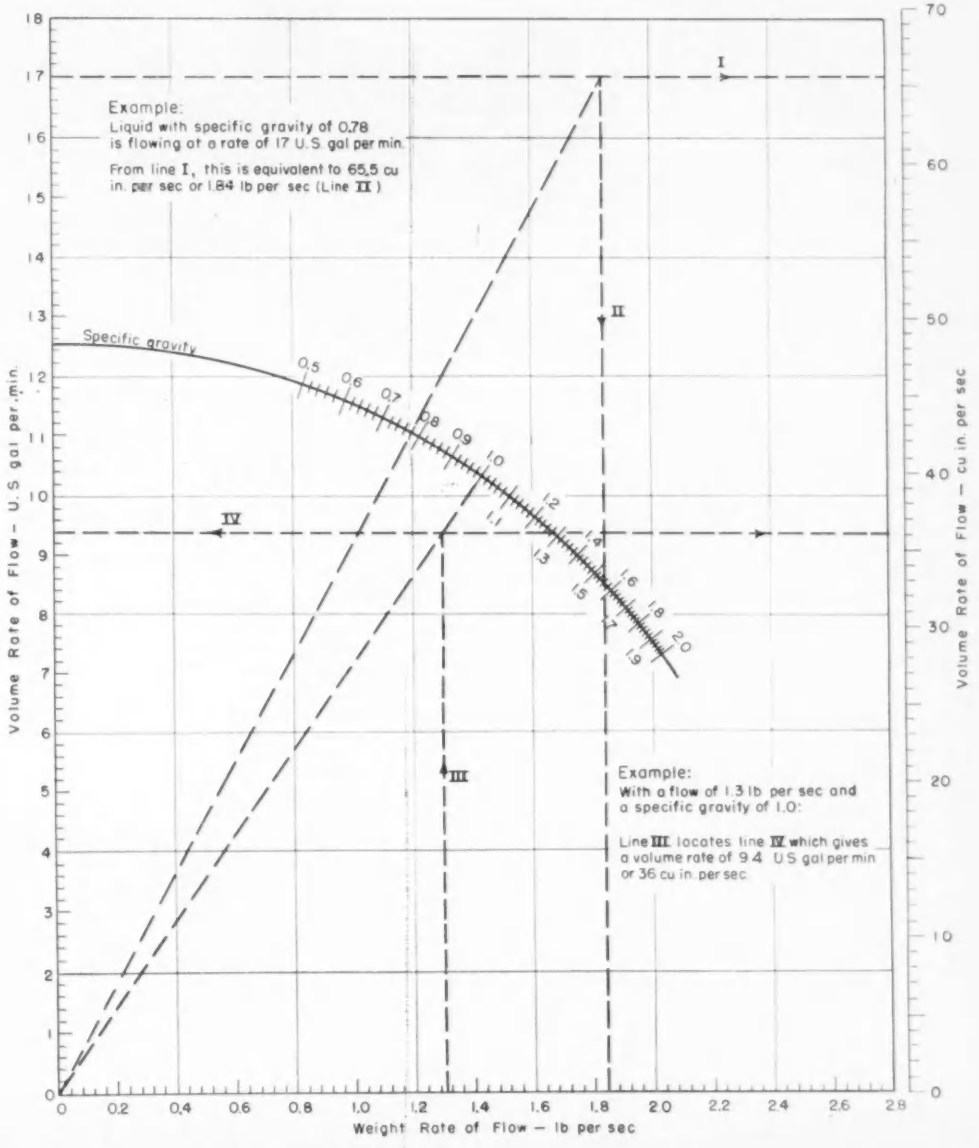
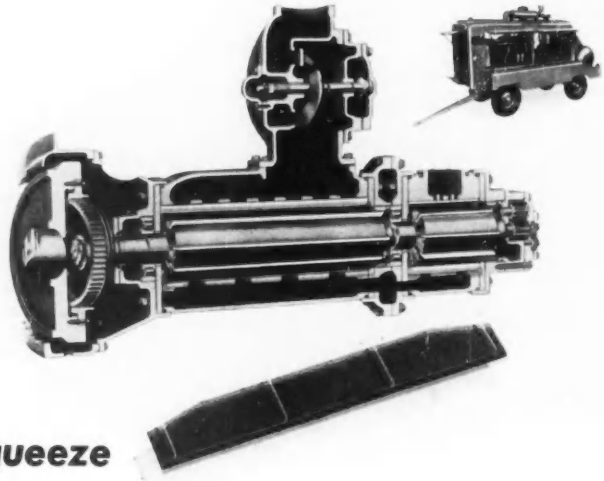
Flow Rate Conversion Chart

NILS M. SVERDRUP
Aerojet Engineering Corp.


Example:
Liquid with specific gravity of 0.78 is flowing at a rate of 17 U.S. gal per min.
From line I, this is equivalent to 65.5 cu in. per sec or 1.84 lb per sec (Line II)
Specific gravity
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
I
II
III
IV
Example:
With a flow of 1.3 lb per sec and a specific gravity of 1.0:
Line III locates line IV which gives a volume rate of 9.4 U.S gal per min or 36 cu in. per sec
Volume Rate of Flow – U.S gal per min.
Volume Rate of Flow – cu in. per sec
Weight Rate of Flow – lb per sec



How to put on the squeeze

In the illustration above you see vanes used in the new Ingersoll-Rand Gyro-Flow portable air compressors. These vanes do an unusual job. They are made from an unusual material—Synthane laminated plastic.

The vanes are inserted in slots in a rotor which is mounted off-center in a cylinder. As the rotor spins, centrifugal action forces the Synthane vanes against the inside of the cylinder to form chambers between the vanes. Because of the eccentric mounting, these chambers constantly change in dimension. As they enlarge, air is drawn through intake ports in the cylinder walls. As they contract, the air is forced under pressure through discharge ports.

The result is a steady flow of compressed air without pulsation or vibration. Because of the complete simplicity of the machine, the compressor is lighter, more efficient, more economical to operate than conventional compressors.

It is apparent that the vanes are important components. They must be strong, light in weight, unaffected by the oils used to lubricate and form an air-tight seal between the vanes and the cylinder walls. They must be hard and dense to stand up under continuous operation yet not so hard as to score the walls of the cylinder.

Synthane has all of these properties and many more. In fact, it has so many useful mechanical, electrical and chemical characteristics that it cannot be adequately described in less than a complete catalog. If you have need for such material, a catalog containing a complete description of Synthane may be obtained by writing Synthane Corporation, 3 River Road, Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

SYNTHANE

Manufacturers of laminated plastics

Radial Deflections of Rotating Disks With Constant Thickness and Central Hole

L. M. PORTER
Design Project Engineer
Pratt & Whitney Aircraft

THE NOMOGRAM SOLVES the equations for the total radial deflection at the inner and outer radius of rotative disks with constant thickness. The equations[1] are based on steel disks with $E = 29 \times 10^6$ psi and Poisson's ratio of 1/3. Since the ratio of density to Young's modulus is almost the same for steel, magnesium, and aluminum, the nomogram can be used for all three materials with an error of about 0.5 per cent for aluminum and 2.5 per cent for magnesium. While the nomogram will solve the equations for any values of the independent variables within the limits of the chart, the resulting values of the deflection are of no practical value if the elastic limit of the material has been exceeded.

The tangential stresses can be found by dividing the total radial deflection by the original radius and multiplying the quotient by the modulus of elasticity, E of the metal.

EXAMPLE:

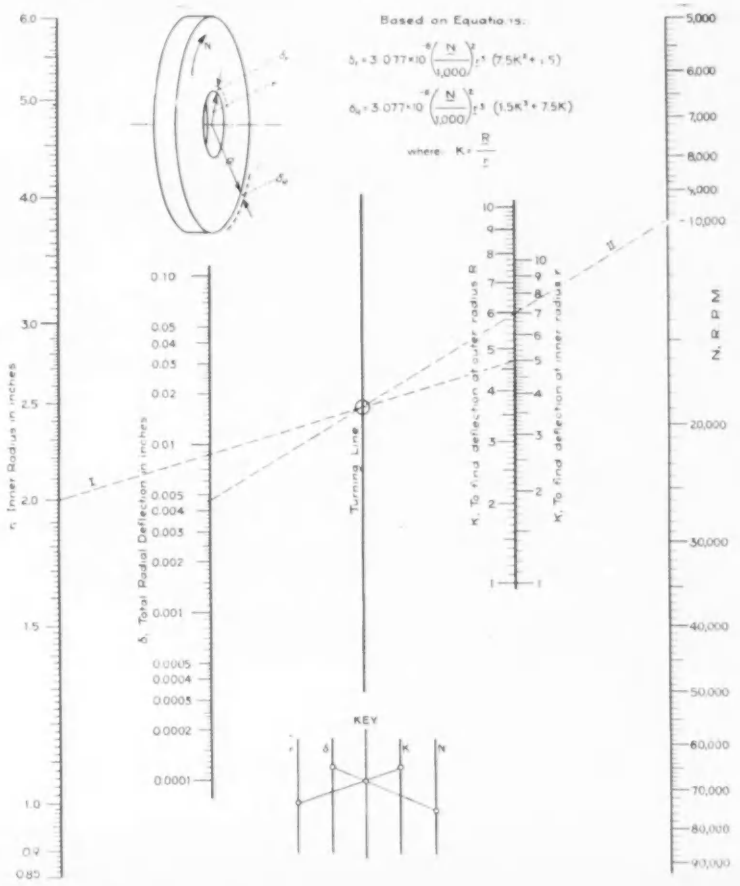
A steel disk with inner radius 2.0 in., outer radius 10.0 in. rotates 10,000 rpm. Find deflection and stress at inner radius.

SOLUTION:

Ratio K of outer to inner radius is 5.0. K scale is graduated on both sides: the left for finding the deflection at the outer radius and the right side for determining the deflection at the inner radius. Line I connects a value of 2.0 on the r scale with 5.0 on the right side of the K scale, establishing a point on the turning line. Line II drawn through this turning point to 10,000 rpm gives δ_i of 0.0046 in. for the radial deflection. The tangential tensile stress is then found to be:

$$\sigma_t = \frac{0.0046}{2} \times 29 \times 10^6 = 66{,}700 \text{ psi.}$$

1. Reference: Derived from equations of A. Stadola in *Turbo-Blowers and Compressors* by W. J. Kearton.


Based on Equations:
$\delta_i = 3.077 \times 10^{-6} \left(\frac{N}{1{,}000}\right)^2 r_i^3 (7.5K^2 + 1.5)$
$\delta_o = 3.077 \times 10^{-6} \left(\frac{N}{1{,}000}\right)^2 r_i^3 (1.5K^2 + 7.5K)$
where: $K = \frac{R}{r}$
r, Inner Radius in inches
δ, Total Radial Deflection in inches
Turning Line
K, To find deflection at outer radius R
K, To find deflection at inner radius r
R P M
KEY
δ
K
N

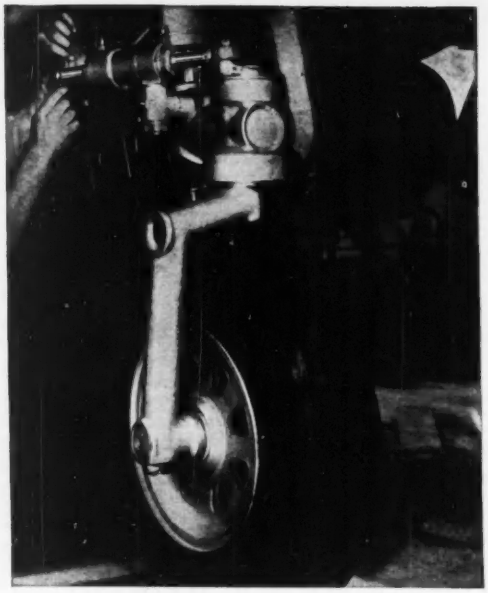
How "PH" Stainless Steels COMBINE 4 ADVANTAGES

Here are two Armco Stainless Steels that combine excellent corrosion resistance, high strengths and hardnesses with low-temperature heat treatments.

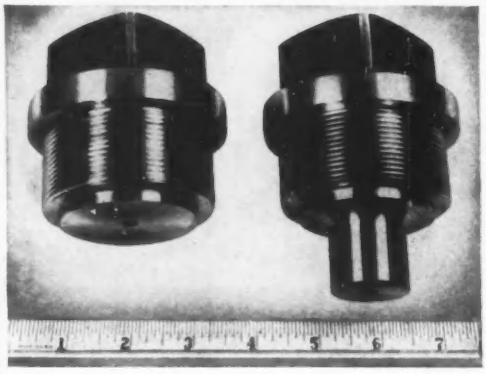
They are known as Armco 17-7 PH and Armco 17-4 PH.

These precipitation-hardening chromium-nickel types offer many new opportunities for the use of stainless steel, and are improved materials for many applications where standard stainless types are now used.

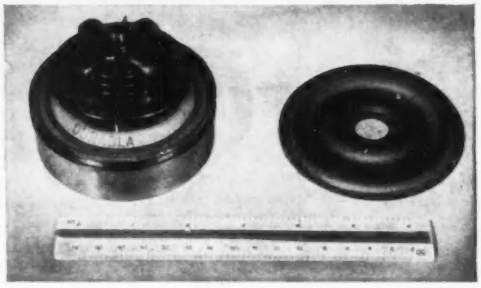
Depending upon condition supplied and subsequent heat treatment, Armco 17-7 PH sheets attain yield strengths of 150,000 to 250,000 psi and hardnesses up to Rockwell C50.



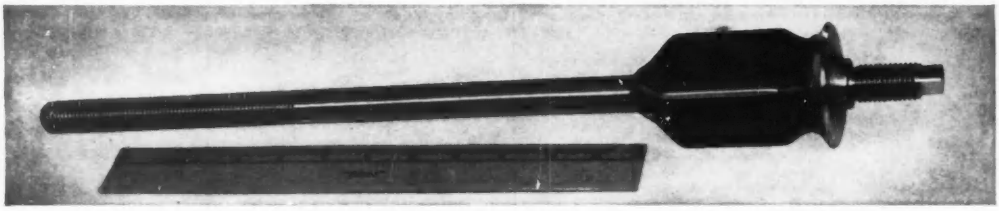
This anti-shimmy damper is one of the 13 production parts of Armco 17-4 PH bar stock used on AJ-1 and B-45 airplanes.



Armco 17-4 PH Stainless Steel bars are used for these valve plugs designed for pump heads in a chemical plant. Plugs are exposed to a solution of basic chromium sulfate at pressures ranging up to 7500 psi. Perfect threads are a "must."



For the best combination of high hardness and corrosion resistance, Armco 17-7 PH strip was chosen for the valve disc of this all-metal pump valve assembly.



Safety valve stem for liquefied petroleum gas tank made of Armco 17-4 PH. This part is upset and forged from bar stock, annealed and machined. Low-temperature heat treatment develops high yield strength without distortion.

ARMCO STEEL CORPORATION

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ARMCO

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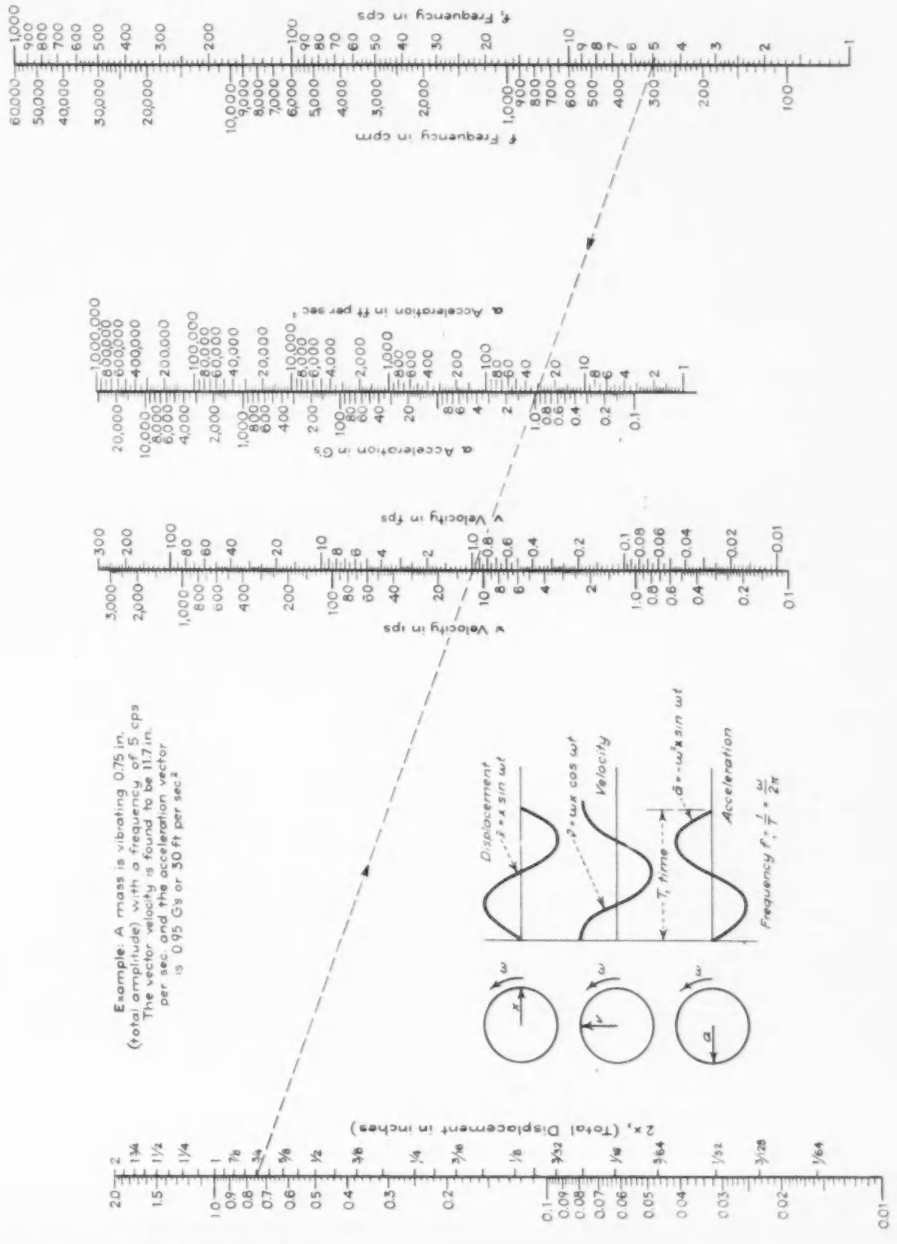
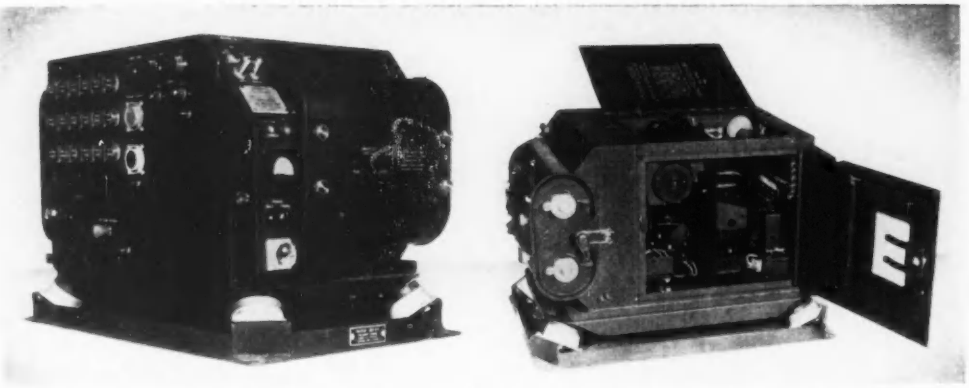
Vibration Nomograph

GEORGE F. FORBES
NOTS, Inyokern, Calif.


f, Frequency in cps
f, Frequency in cpm
a, Acceleration in ft per sec²
a, Acceleration in Gs
v, Velocity in fps
v, Velocity in ips
2x, (Total Displacement in inches)
Example: A mass is vibrating 0.75 in. (total amplitude) with a frequency of 5 cps. The vector velocity is found to be 11.7 in. per sec, and the acceleration vector is 0.95 Gs or 30 ft per sec²
Displacement
Velocity
Acceleration
T, time
Frequency f = 1/T = ω/2π



THE 4-POINT SHOCKMOUNT BASE of low frequency and based on the effective-center-of-gravity principle is standard equipment on the 5-114 recording oscillograph. Although it is used to guard against vibrations, it may be quickly detached. For extended tests, spare loaded magazines may be kept ready for replacement with only a short interruption of the test.

Oscillograph Records 18 Items of Test Data Simultaneously

Recording simultaneously as many as 18 distinct items of test data, the 5-114 Recording Oscillograph permits the studying of all phenomena in their true relationship to time and to one another. This multi-channel oscillograph, used for the analysis and measurement of strain, vibration, pressure, acceleration, and other high-frequency action, will record this data photographically at speeds of ½ in. to 115 in. per sec. Applications of this instrument have included: jet-aircraft flight tests; static tests of concrete structures; cardio-vascular research; performance tests of farm tractors; evaluation runs of guided missiles; and the measurement of the plastic deformation of stressed metals.

One of the main features is the timing system. The timing lines are photographed across the full width of the record simultaneously with the data traces to give accurate time correlation. The timing system, independent of the record speed, provides lines at 1/100 sec intervals, with every tenth line accentuated to simplify record reading. The 1/100 sec lines may be eliminated by one adjustment, and the intensity of all lines may be controlled by a single voltage adjustment.

The record gear drive system gives positive engagement by a changeable-gear transmission that uses neither belts nor friction drives. Without the use of tools, record speeds may be changed from ½ in. to 115 in. per second.

Identification of crossing or closely parallel traces is simplified by a device which interrupts each trace periodically at the same spacing, regardless of record speed. In this way a trace may be easily followed by noting the sequency of interruptions. Three adjustable, static reference-trace markers provide base lines for measurement of amplitudes and displacements. Their traces may be located laterally on the record at any point. The dynamic reference trace is used to record external timing pulses which is used as an aid when several oscillographs are used in multi-plex, or may be used as a fourth static reference trace.

Record length may be preset at from 2 to 55 in. by a front-panel dial. Putting the record-drive switch to the automatic position will cause a record of the exact, pre-set length to be taken. After this, the motor stops and the oscillograph resets itself for the next record.

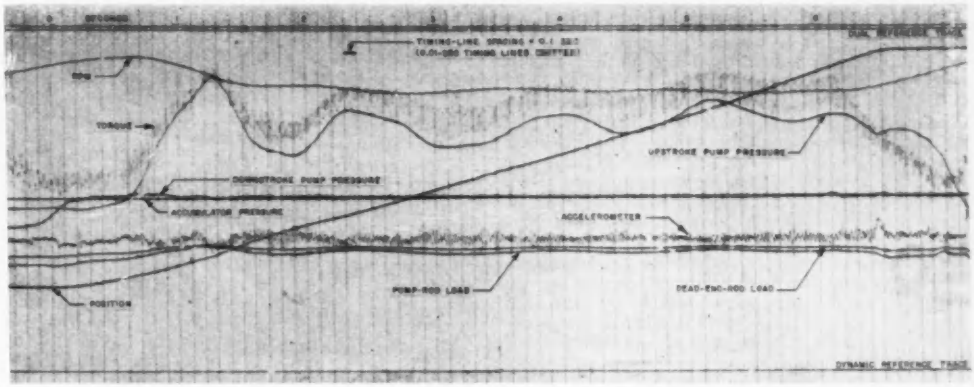
The heart of the oscillograph is found in the 7-200 series galvanometers. This permits a great record-speed range of the oscillograph, and allows recording of both static conditions and high-speed transients. Many combinations of sensitivity and frequency response are available. A single magnet block, cast in one piece of Alnico V, furnishes the field for all galvanometers and assures alignment as well as a stable uniform flux. Tilt adjustment mechanisms are integral with the block and are easily accessible. Thermostatically controlled heating, holding the block at 100 F ± 1F, maintains the stability despite variations of ambient temperature.

Other features include a warning system that notifies the operater if the paper is feeding improperly, or of anything that will prevent a good record. Recording paper magazines are available in 125, 250, or 600 ft capacities. The 600 ft magazine permits a continuous run of over two minutes at 50 in. per second.

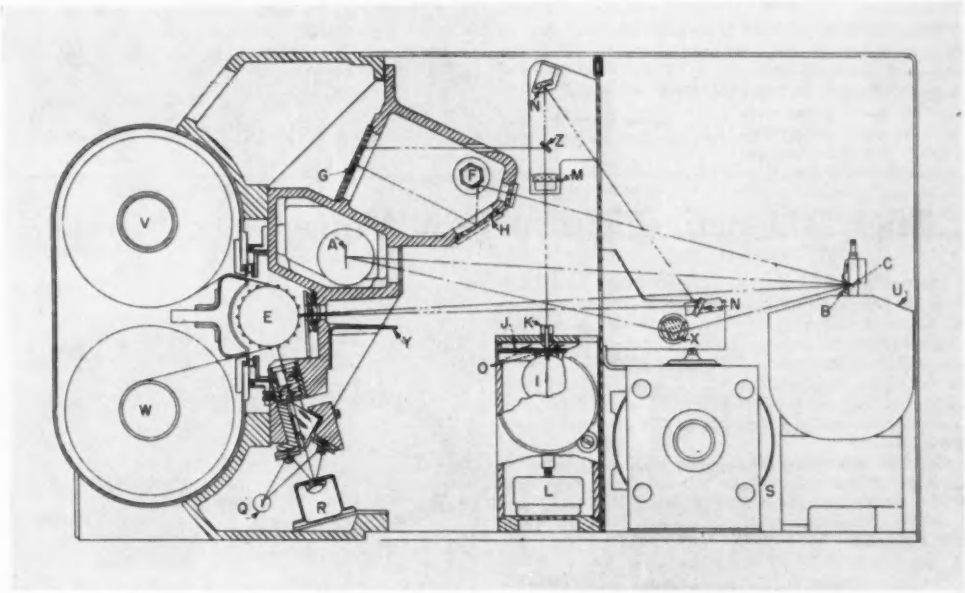
Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

MATERIALS - PARTS

SPECIFIED BY PRODUCT ENGINEERS



THE PERFORMANCE OF each important component in relation to all the others at the instant of operation is shown above in the test record of an oil-well pump. The timing lines are photographed across the record at the same time as the data traces, giving 1/10 or 1/100 second time correlation. Every tenth line is accentuated to simplify record reading.



THE OPTICAL SYSTEM: (A) recording and scanning lamp filament; (B) galvanometer lens; (C) galvanometer mirror; (D) recording collimating lens; (E) record drive sprocket; (F) polygon; (G) viewing screen; (H) viewing mirror; (I) timing lamp filament; (J) timing shutter disks; (K) shutter indexing knob; (L) timing motor; (M) timing condensing lens; (N) timing mirrors; (O) aperture plates; (P) record number lens cell; (Q) record number lamp; (R) record number counter; (S) record drive motor; (T) record drive motor governor; (U) galvanometer magnet; (V) magazine feed roll; (W) magazine take-up roll; (X) viewing prism; (Y) light shield; and (Z) mirror-visual timing. When more fixed reference traces than the three provided with each oscillograph are needed, they may be added at any point in the magnet block and adjusted.

CONTINUED ON PAGE 204

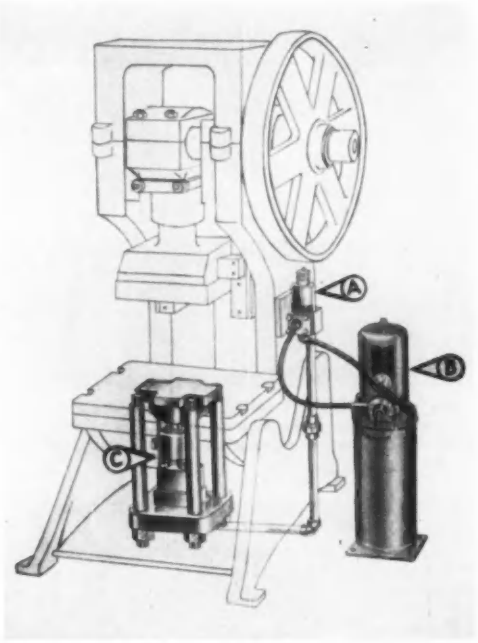
Overload Safety Unit Used on Power Press

All power presses require not only the protection from overload damage, but the assurance that a constant work pressure is produced on part being worked upon. This new hydraulic press bed jack is said to fill these requirements.

The bed jack can be fastened directly to the bolster plate or press bed frame as shown at C in the illustration. The unit at B is the hydropneumatic pumping means that can be operated directly off the average shop air line. The control valve at A can be set at any desired tonnage, giving the press the desired overload protection. Also it can be so adjusted to give the tools being used the desired overload protection.

This hydraulic overload press bed jack can be used on all such operations as riveting, marking, stenciling, squeezing, assembling, forming, swaging, staking and other such operations. The bed jack is said to assure constant working pressure at all times at the point of operation, and will compensate for variation in the piece part material thickness. All such operations can be done at a high degree of accuracy, providing definite compensation for accumulated errors in the piece part, which will eliminate all discrepancies in the finished piece part, assuring both press and tool protection. This equipment can be applied to any power press now in operation, and can be removed when not wanted.

These hydraulic overload press jacks are now made in eight sizes, up to and including a maximum of 200 tons. Further information on these and other overload safety units may be obtained from the manufacturer.



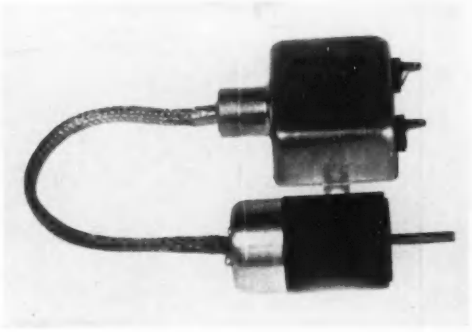
Dayton Rogers Mfg. Co., 2824 13th Ave., So., Minneapolis 7, Minn.

High Magnetic Field in Low Voltage D-c Motors

The newly developed 21A d-c low voltage motors are all of the permanent magnet field type employing a powerful Alnico V ring magnet. This magnet design provides a high magnetic field which, is said to account for the good performance of this motor. The motor housing is entirely die cast from plaskon alkyd 422, a new plastic of high mechanical and electrical properties. The mica insulated commutator contains 14 segments to give good stability of operation.

The 21A motor may be supplied with many different windings for use with voltages between 6 and 110 volts. Typical performance, is illustrated by model 21AA1 designed for blower and gyro service 26-28 volts. Voltage, 27.0 v nominal; hp, 1/75 hp continuous duty (0.7 in.-oz. torque), 1/35 hp (max) intermittent duty (2.4 in.-oz torque); current, 1/75 hp—0.7 amp, 1/35 hp—1.6 amp; speed, 1/75 hp—19,000 rpm, 1/35 hp—14,500 rpm; efficiency, 50-55 percent at rated loads.

The motor is supplied either shielded or unshielded. The shielded models with an appropriate line filter are designed to meet applicable AN electrical interference specifications. Brushes may be supplied in a variety of grades to give longer life under high or low loads.



The die casting of the housing with the field magnet as an insert is said to assure armature alignment even under the severe conditions of shock and vibration.

El Ray Motor Co., Inc., Los Angeles, Calif.

CONTINUED ON PAGE 206

To write piping specs faster...
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You'll write 'em up faster then—for many reasons. Your Crane Catalog not only contains an unequaled selection of quality piping materials, but also lists every item so you can find it in a hurry... find out all about it, too. Complete breakdown on every valve and fitting includes sizes and dimensions; tabulated pressure and temperature ratings; design, material, and construction details.

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FOR ALL-ROUND SERVICE on steam, water, oil, or gas lines... Crane recommends 125-Pound Iron Body Wedge Gate Valves, brass trimmed or all-iron. Available in Non-Rising Stem, O.S. & Y., Underwriters', and Quick Opening patterns. Screwed, flanged, or hub ends. Sizes: 2-inch and larger. See your No. 49 Crane Catalog, pages 77-81.

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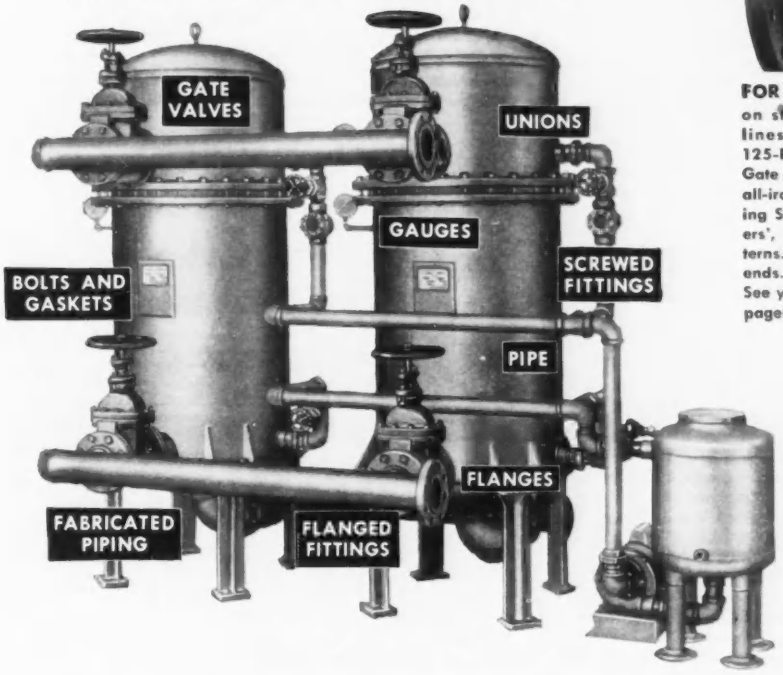

Water Feed Filter by R. P. Adams Company, Inc., Buffalo, N. Y.

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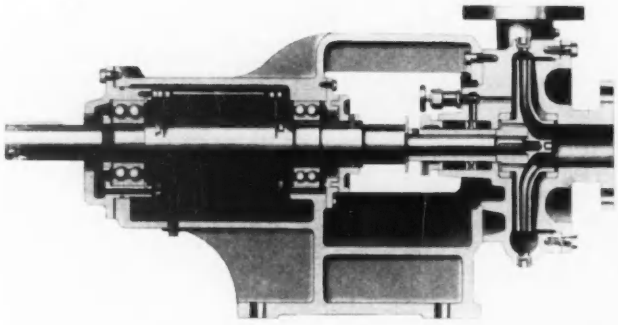
All Purpose Pump For Corrosive Liquids

Used for handling chemicals, liquors, corrosive and abrasive solutions, petroleum, and hot liquids, this pump is available in sizes with capacities to 1,200 gpm at heads to 250 ft, and temperatures to 500 F. It can be had in stainless steel, monel metal, nickel, or other special material when used for pumping liquids which would attack iron or bronze. The high-efficiency enclosed type impeller used may be made of any material, depending upon the service for which it is intended.

Several sealing arrangements are available. The cutaway view shows a standard internal sealing arrangement with a packing gland, where the liquid being pumped is used as a sealing medium. The internal liquid passage has a needle valve for regulating the flow. Alternate sealing arrangements are: the external water seal; an external grease seal; a water cooled stuffing box; single inside mechanical seal; a double inside mechanical seal; and a single outside mechanical seal.



Bearings are of the double-row, oil lubricated type. Oil is carried to the bearings by two oil rings running in an oil reservoir. The use of oil also permits operation at higher temperatures. An "O" type seal between the end cap at the coupling end and the pedestal is used. A labyrinth seal is also used between the end cap and the oil slinger.

The unit may be supplied with the complete unit—pump, motor, drive, and control—all mounted on a rigid base ready for operation. Pumps are available with direct coupling or V-belt drive.

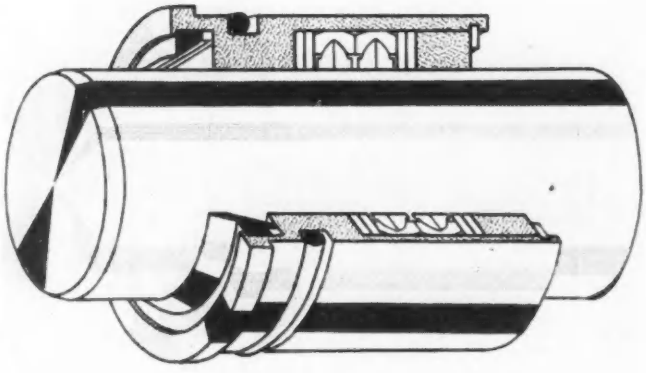
Two sizes of pedestal assembly cover the entire range of pump sizes. Shafts, sleeves, bearings, and miscellaneous parts are interchangeable.

Allis-Chalmers Mfg. Co., 1002 S. 70th St., Milwaukee, Wis.

Packing Containers For Hydraulic Cylinders

Monopak-Cartridges for pneumatic and hydraulic cylinders, are said to provide simple solution to problems of assembly and maintenance. They combine all the necessary packings, bearings, and rod-wipers into one compact unit, which can be installed or replaced within a few seconds. Designed to make use of the long-wearing properties of the packings, they require no attention and are said to outlast other parts of the cylinder.

They consist of a bronze housing, containing monopak metallic packings, seal-guard rod wipers, and bronze bushings, and are confined in the cylinderhead by means of a snap-ring which is readily accessible from the outside. No adjustment is necessary, either before, during, or after the initial installation, and once in place they cannot be tampered with in any way.



Monopak-Cartridges are now available for light or heavy duty service in three distinct designs, for rod sizes ranging from $\frac{5}{8}$ in. to $3\frac{1}{2}$ in. in diameter. This unit has a structural safety factor of not less than 6:1.

Hydraulic Accessories Co., 139 E. Fort St., Detroit 26, Mich.

CONTINUED ON PAGE 208

Other engineers are finding many new uses for this new SR-4® device . . . *How about you?*

Further expanding the engineer's field of exact knowledge, the Baldwin SR-4 Fluid Pressure Cell opens entirely new opportunities in the precise measurements of both stable and fluctuating pressures in all types of fluids.

Heart of the cell is a pressure-sensitive tube with an SR-4 strain gage grid bonded to its exterior. Gas or liquid to be measured enters this tube, causing it to expand, which stretches the fine wire in the grid. The consequent alteration in electrical resistance, calibrated in p.s.i. or other units, is measured by an indicator or recorder, or actuates monitor or alarm apparatus.

The cell is easily installed, and is adaptable to use with all types of fluids—corrosive or non-corrosive—and over a wide range of pressures. A wide variety of indicating, recording and controlling instrumentation is available to meet your particular requirement. Calibration inaccuracy is not more than ¼% of full range at any point from 0% to 100% of capacity, and this measuring performance is maintained under hundreds of thousands of pressure cycles. The unit is extremely responsive to pressure fluctuations making it invaluable for research on surges and similar pressure fluctuations, and explosion studies. For more detailed information, ask for Bulletin 306. One of our representatives will be glad to discuss the application of these cells to the solution of any fluid pressure measurement or control problem you may have.

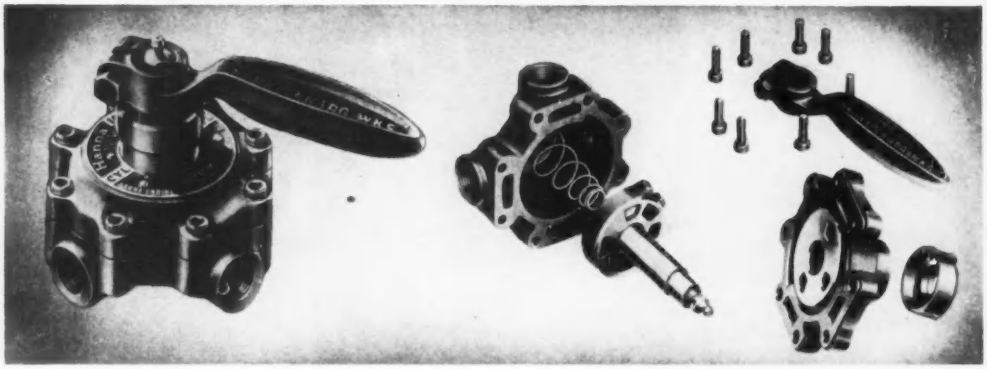
BALDWIN BLH LIMA-HAMILTON

BALDWIN-LIMA-HAMILTON

TESTING HEADQUARTERS

EDDYSTONE DIVISION, BALDWIN-LIMA-HAMILTON CORPORATION, PHILADELPHIA 42, PA.

In Canada: Peacock Bros., Ltd., Montreal, Quebec



Packless, Hand Operated Three and Four Way Valves

Features of the Unitite, hand operated valve are: a chrome-plated stem for minimum wear; a neoprene stem collar to prevent abrasion from dust; a standard grease fitting at the top of the stem; and a bronze disk. The valve handle movement is limited by internal stops to allow 360 deg optional handle placement for operator's convenience.

Unitite valves are small to accommodate installation in limited space, compact, packless and have an exterior to minimize dirt accumulation. Three mounting styles, stand, column and manifold, are available to meet all requirements.

The standard mount is used in installations where the valve is mounted on the cylinder or where it can be supported by the piping. The Manifold mount is used for installations where several valves must be grouped closely together. All ports are in the mounting face of the valve. Necessary piping to and from the valves does not interfere with piping to adjoining valves. Intake and exhaust openings may be connected to single supply or exhaust pipes, or to a manifold or pulpit block. The column mount is used in remote control installations where it is desirable to provide support in addition to that given by the piping. Disassembly is easy, as the bonnet and all body parts may be removed without disturbing the piping. All the ports of the valve are identified on the valve name plate.

To insure long life, it is important that the air, oil or water used as operating medium is clean. Valves for oil operation need no further lubrication. When air or water is the operating medium the valve needs lubrication. The manufacturer states that tests on the valve show that it will give maintenance-free operation for 10 to 15 million or more cycles.

Unitites are made for 3 or 4-way operation by air, oil or water, up to 250 psi in $\frac{3}{8}$ in., $\frac{1}{2}$ in. and $\frac{3}{4}$ in. sizes, to 150 psi for the 1 in. size, and up to 100 psi for the $1\frac{1}{4}$ in. size.

Hanna Engineering Wks.,
1765 Elston Ave., Chicago 22, Ill.

New Welding Electrode Saves Copper

A new type of resistance welding electrode, marketed under the name Kaptrode, consists of an expendable cap which fits into a semi-permanent adapter shank, which in turn fits into any standard Morse taper type electrode holder. Depending upon the length of the adapter shank, copper savings up to 75 percent are possible.

Kaptrode electrodes are made in six nose styles (pointed, dome, flat, offset, truncated cone and radius face), in three RWMA alloys (Class 1, 2 and 3), and two Morse taper sizes (No. 1 and 2).

Adapter shanks are made at present in two Morse taper sizes and nine lengths ranging in $\frac{1}{4}$ in. steps from $1\frac{1}{4}$ to $3\frac{1}{4}$ inches. Other lengths are manufactured to specifications. All Kaptrode electrodes fit interchangeably into any adapter shank of the corresponding Morse taper size, and project $\frac{3}{4}$ in. from the shank. Thus, with the proper shank length, it is possible to duplicate standard electrode lengths and use Kaptrode electrodes without changing established machine set-ups.

The Kaptrode electrode is fitted into the adapter shank by a blow of a rubber or rawhide mallet, or by pressure of the welding machine. Electrodes are removed with the Kaptrode extractor, a tool similar to the toggle pliers.

The manufacturer claims that workout tests made in motor car plants show that under ordinary wear and tear of shop conditions, one adapter shank should outlast ten Kaptrode electrodes, with longer life possible. At this rate, electrode costs are reduced 20 percent more. The use of Kaptrode electrodes is said to reduce users' inventory stocks of resistance welding electrodes, constituting a further saving, both in costs and in copper.

Fansteel Metallurgical Corp.,
11644 Cloverdale Ave., Detroit 4, Mich.

CONTINUED ON PAGE 211

GITS *Unit** SEAL
Now STANDARDIZED

For . . .

Gear Reduction Units
Aircraft Reciprocating Engines
Automotive Accessories
Jet Propulsion Units
Washing Machines
Standard & Special Machine Tools
Electrical Power Equipment
Business Machines

If *you* have a shaft sealing problem, Gits experience in these and many other specific applications can prove of great and immediate value to you.

Write today for FREE illustrated Brochure, or send us your seal problem.

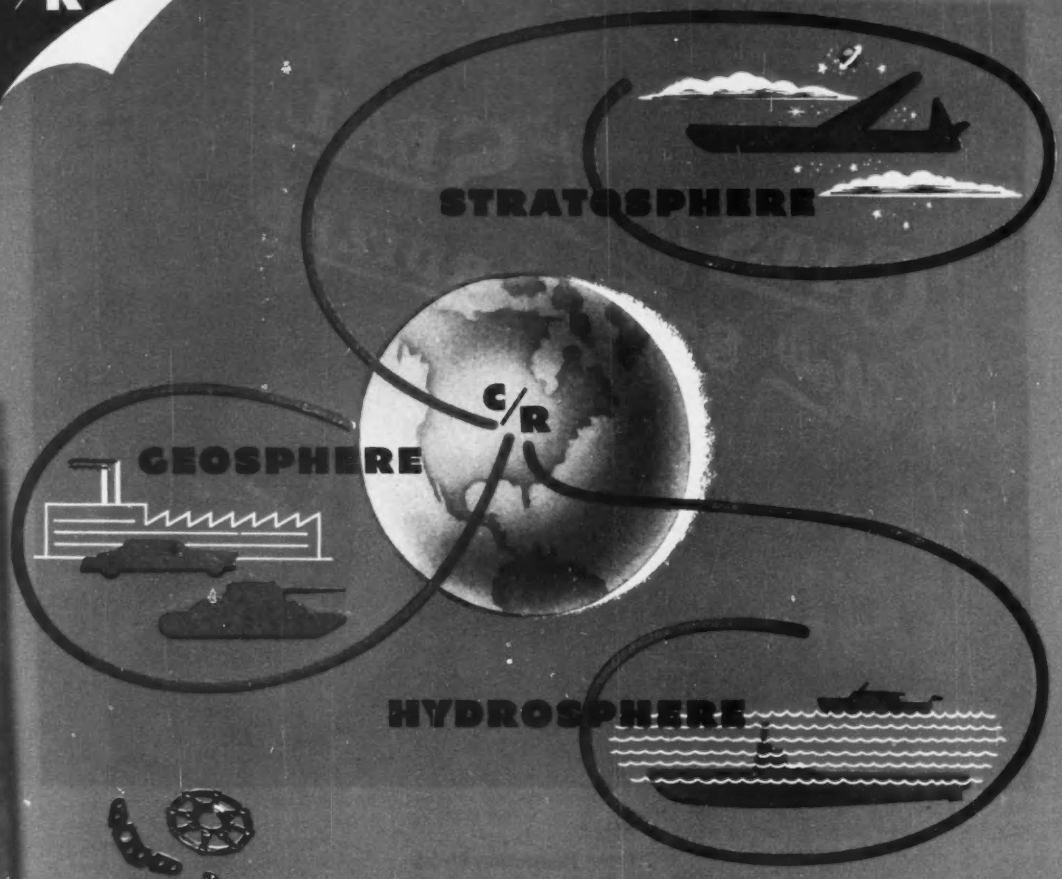
*Cartridge Seal . . . pressure balanced . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Ave. • Chicago 23, Ill.

Gits Lubricating Devices,
The Standard For Industry For Over 40 Years

C/R



In whatever medium your mechanism operates . . . land, sea or air . . . Sirvene will best solve your pliable parts problem with a tough, new gasket, boot or diaphragm. Working from your own specifications, Chicago Rawhide engineers will make the needed design—regardless of "near-impossible" demands—and mass produce your part from scientifically compounded elastomers (synthetic rubber.)

You can be sure that the resulting part will have the exact degree of flexibility, hardness, resistance to extreme temperatures, fluids, gases, abrasion, wear and any other qualities you require. At present, Sirvene is serving dependably in thousands of unusual and difficult situations on land, sea and air. It can do the same for you.

ENGINEERS: For basic information, write for your copy of "Engineering with Sirvene". There is no charge.

CHICAGO RAWHIDE MANUFACTURING CO.
1299 Elston Avenue **SIRVENE DIVISION** Chicago 22, Illinois

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Mechanical Leather Products
Boots, diaphragms, packings and other products give dependable service under difficult operating conditions.

***PERFECT** Oil Seals*
C/R seals are used in more motor vehicles, farm implements and industrial machines than any other shaft-type sealing device.

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THE *SCIENTIFIC* COMPOUNDED ELASTOMER

Boston • New York • Syracuse • Philadelphia • Pittsburgh
Cincinnati • Cleveland • Detroit • Peoria • Minneapolis
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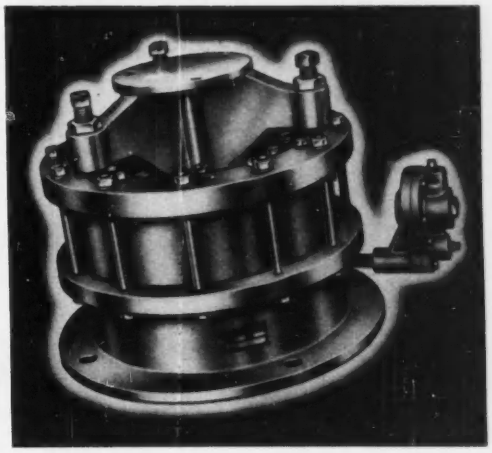
Pneumatic Scale Measures and Controls Weight

The F-C "air scale" weight transmitter, a completely pneumatic scale for either batch weighing or continuous process control, accurately converts a variable force or weight into an easily measured pneumatic signal. Operating on the force-balance principle, the weight transmitter will indicate, record, or control weight or force through standard instruments in the manner commonly applied to temperature, flow, pressure, and level problems. Uses range from weighing operations to batch or continuous flow control of either solids or liquids and torque and thrust measurements of jet engines.

In operation the scale balances out any tare thus allowing net weight to be indicated directly on standard panel board instruments. Accuracy of the net weight output of the air scale is limited only by the characteristics of the indicating instruments used with it.

The mechanism is free of lost motion and friction due to the elimination of all balance beams, knife edges, and springs. Thus maximum sensitivity, ruggedness and pinpoint accuracy are assured. Total movement is restricted to $\frac{1}{8}$ in. including overtravel, thereby fully protecting all components from mechanical damage even under heavy loads.

Because the weight transmitter is completely enclosed and requires no electricity for remote indication, explosion hazards are said to be eliminated along with danger of damage by chemicals, corrosive materials, or dust. Thus these pneumatic scales may be adapted for use in the chemical, food processing, milling, glass and similar fields.



The unit is capable of weighing up to 10,000 lb, and occupies less than one cu ft of space. Sizes of this compact unit are available to weigh up to 40 tons directly. Higher measuring units can be obtained on special order.

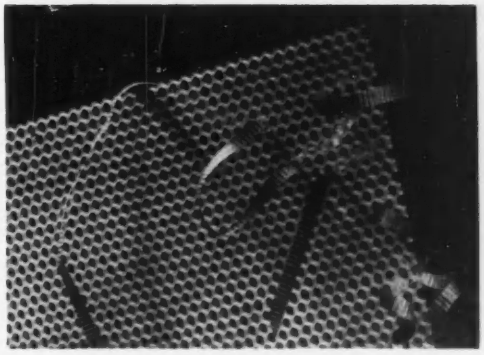
Fluid Controls Co., 5150 Ridge Ave., Philadelphia 28, Pa.

Precision Cut Glass Used For Electronic Circuits

A new kind of glass which can be precision-machined through the use of ultraviolet light, heat and hydrofluoric acid to form intricately cut patterns of any desired shape and depth, is the latest in a series of photosensitive compositions which will produce permanent three-dimensional photographs in glass in a variety of colors. To the new composition, which is a special kind of photosensitive opal glass, has been adapted a new process of chemical machining, which produces without the aid of mechanical tools, lace-like patterns.

The first step in the process is the printing of a design in the glass, using an ordinary photographic negative and ultraviolet light. Development is then accomplished by heating the glass to 1,200 F for the required length of time, usually about two hours. At this stage, a milk-white image appears in the otherwise transparent glass.

Next, the glass is immersed in a solution of hydrofluoric acid until the white areas are eaten through and removed, leaving the remaining unexposed glass in the exact form of the original pattern. By varying the length and intensity of light exposure through the photographic negative, the depth of acid penetration in the glass can be accurately controlled from shallow etching to complete erosion. In this way, sculptured figures or contoured shapes can be made by using a continuous tone negative



with proper degrees of shading. Since chemical machining involves no mechanical stress, patterns otherwise too complex to reproduce in glass or any other material without long and tedious work can be simultaneously reproduced in any number and with photographic accuracy by this method. Printed electrical circuits are good examples.

Corning Glass Works, Corning, N. Y.

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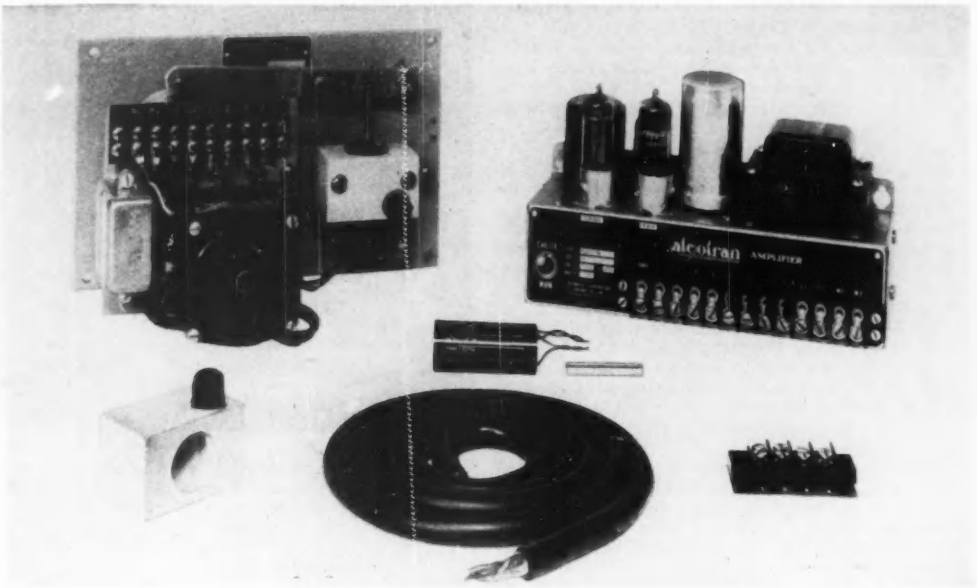
Servo-Mechanism Kit Has Variety of Uses



This servo kit, basically a servo-mechanism system operating on the linear transformer principle, allows for measurements of straight line motions such as the displacement of a bellows or diaphragm, the motion of a float, the tip travel of a bourdon tube, and the tilt of a weigh beam.

With this kit, containing a differential transformer, a standard servo mechanism, an amplifier, a terminal block, a mounting block, and a 4-wire connection cable, it is possible to measure force, motion, torque, tension, thickness, edge position, and others. By connecting the servo mechanism, the differential transformer and amplifier in a null balance circuit, the output of the servo will drive a pen on a recording chart; operate a pointer on an indicator; position slide wires for electrical controls or contacts; drive pulleys or cams; and position hydraulic valves or pneumatic cylinders.

The differential transformer consists of a 4-winding ceramic coil with a plastic cover and an armature that operates within the coil. The primary winding is connected, in series with the primary winding of the coil in the servo mechanism and the high gain amplifier. When the armature is located in the exact electrical center of the coil, the secondary output is zero; but when the armature is moved off center, an a-c signal with a linearity within $\frac{1}{10}$ of 1 percent is generated in proportion to the amount of motion and in a phase relative to the direction of the motion. The secondary winding is connected in series with the transformer of the servo mechanism and the amplifier input curcuit.

When a signal exists, due to one armature being at a different relative position than the other, it is amplified and the resulting output signal actuates the servo mechanism motor. The motor will run in either direction depending upon the phase of the signal determined by the direction of the armature.

The standard coil, which is used to measure relatively small motions, is 2 in. long by $\frac{3}{8}$ in. O.D. D-c resistance of the coils is 22 ohms. Inductance of the primary coil, series aiding, is 12 mh while the secondary coil, series bucking, is 5.2 mh. Linear range is plus or minus 0.15 in. Magnetic pull on armature at a distance of 0.05 in. away from center, or null position, is less than 0.01 grams. It has a mechanical calibration adjustment, a micrometer zero adjustment mechanism and makes full scale rotation for 0.1 in. transformer armature deflection for standard units. Other servo mechanisms are available for 0.25 in. and 0.3 in. armature motion.

The servo unit can be supplied in three speeds: 2 sec (torque 15 oz-in.), 4 sec (torque 30 oz-in.), or 10 sec (torque 60 oz-in.). It has a sensitivity of 5,000 motor-driven positions with linear accuracy of plus or minus 0.2 percent of ull range. Larger transformers have a 0.3 percent accuracy.

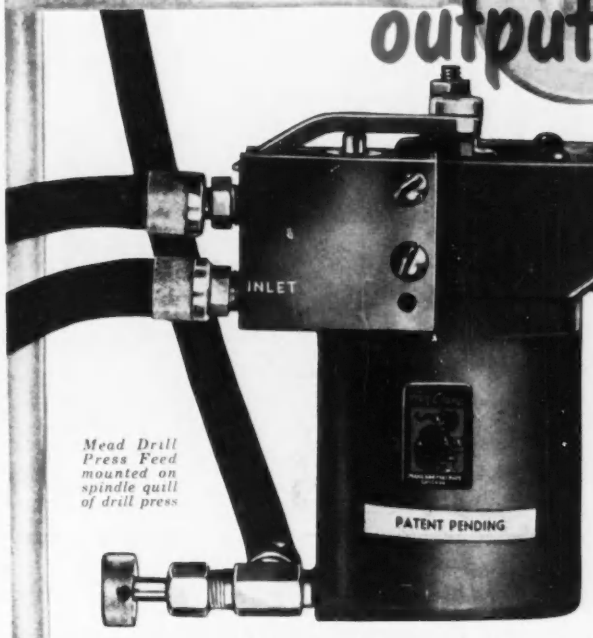
Because the system operates on an electrical signal, there is no time lag between the original signal and its resultant indication. And, because of the 22 ohms resistance, transmitters and receivers can be installed up to 5,000 ft apart with very little loss of signal.

Isolated from ground, the amplifier is equipped with a check switch for zero adjustment of the receiver and is unaffected by line voltage changes of plus or minus 10 percent.

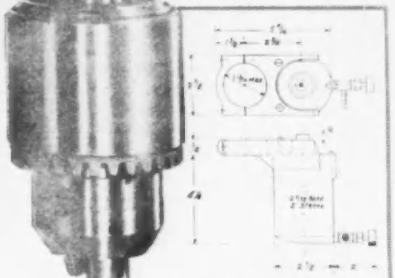
Automatic Temperature Control Co., 5200 Pulaski Ave., Philadelphia 44, Pa.

CONTINUED ON PAGE 214

Double your drill press output for $33.00



Mead Drill Press Feed mounted on spindle quill of drill press



DRILL PRESS FEED NO. 1
Specifications: *Power factor, 4 times line pressure; Stroke, 2½" (approx); Bore, 2⅜"; Capacity, ½" steel Weight, 2 lbs. (approx).*

Use a new MEAD *pneumatic drill press feed for* DRILLING, TAPPING, REAMING

This simple, inexpensive device quickly converts standard drill presses into semi-automatic machines; doubles production on suitable jobs in many cases. Clamps to spindle quill in a few seconds. Automatically closes air fixture on work. Adjustable feed control and break-through cushion. Quick return. Easy to synchronize with automatic cycle equipment. Fits any size press up to 2⅛" spindle diameter. Use genuine Mead Pneumatic Drill Press Feeds for faster, cheaper, more profitable production. Get the facts—send coupon.

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Lightweight Engine Mounting For Aircraft

A new lightweight dynafocal engine suspension known as the MR-41 has been adopted as standard equipment on model 1049 Lockheed Constellations. By departing from usual design methods and employing new structural shapes, it has been possible to effect a saving in weight of approximately 4 lb per engine mounting assembly. Use of the MR-41 Dynafocal provides each Constellation with an additional 16 lb of payload capacity.

Low natural frequencies make it possible for the MR-41 Dynafocal to isolate a high percentage of engine vibration. It is anticipated that the suspension will contribute to the refinement of the vibration characteristics of Constellations; increase passenger comfort; reduce operation fatigue on long flights; and expose structural members to lower dynamic stresses.

The number of component parts in the MR-41 Dynafocal has been reduced, thus simplifying maintenance and reducing spare parts inventory. Snubbers which offer high damping characteristics are incorporated into the individual mountings to prevent metal-to-metal bottoming during periods of abnormal stress. The dynafocal is one of the types of engine suspensions developed by this company. More information may be obtained from the manufacturer.

Lord Mfg. Co., Erie, Pa.

Single Sweep Accessory Used With Oscillograph

The type 121 single sweep accessory is designed to provide one and only one pulse to trigger the single sweep of a cathode ray oscillograph at the start of any complex wave pattern, and at no time thereafter. The 121 will give a single negative output pulse for triggering the single sweep from either a positive or negative input signal without the necessity of separate adjustments for positive and for negative signals.

The signal input required to the type 121 is approximately 0.1 and may be obtained from the signal itself or from an external transducer such as the type 140 synchronization pickup, or a photo cell produced by this company.

The single sweep accessory has its greatest application in the field of photography from cathode ray oscillographs, where it is desired to record a single trace without interference from successive traces. It may also be used to trigger a cathode ray oscillograph from a single, non recurrent pulse when the time of its occurrence is not known.

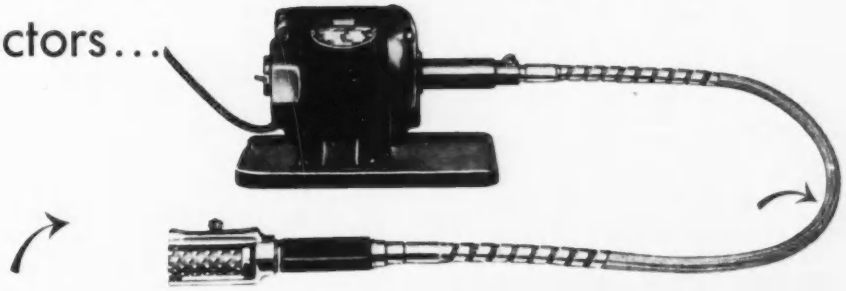
The Sterling Instrument Co., 13331 Linwood Ave., Detroit 6, Mich.

A SIMULATED METAL FINISH for wood products permits conservation of critical materials used in accessories for radio and television cabinets and many other products. It is said to retain its luster and metallic appearance even after severe usage. Knobs finished with this material are available from the manufacturer. Warsaw Products, Inc., Warsaw, N. Y.

A NEW TYPE OF DECAL, made of vinyl materials, is welded to a vinyl sheeting, becoming an integral part of the fabric so that if the material stretches, the decal is elastic enough to be extended without cracking or flaking. The vinyl decal, specially designed for aircraft is used on bullet sealing fuel cells. Goodyear Tire & Rubber Co., Akron, Ohio.

CONTINUED ON PAGE 216

If your product calls for action from connectors...



Fish Story: What could be easier than scaling a fish—if you use this model FSB Fish Scaling Machine made by The Baimar Corp., N. A. Strand Div., Chicago? The flexible shaft driving the cutter is protected in 7/16" I.D. American Type SL Flexible Steel Hose jacketed with an outer braid.

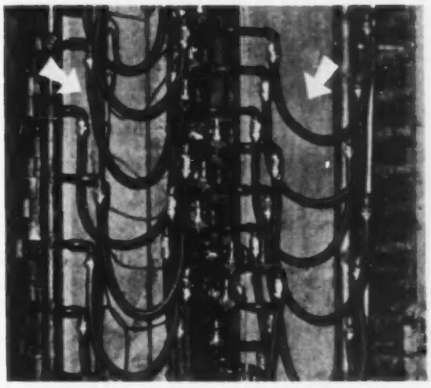
Use American Flexible Metal Hose or Seamless Tubing—the completely flexible metal connectors—where piping connectors move or vibrate; where ports are misaligned or for piping in cramped spaces where there's little room to work.

American Flexible Metal Hose and Tubing are available for carrying almost any liquid, gas or semisolid under severe conditions of corrosion, temperature, pressure and mechanical stress. You'll find full details in Bulletins SS-50 and CC-300. We would like to send you copies. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Co., Ltd. Distributors in all key cities.

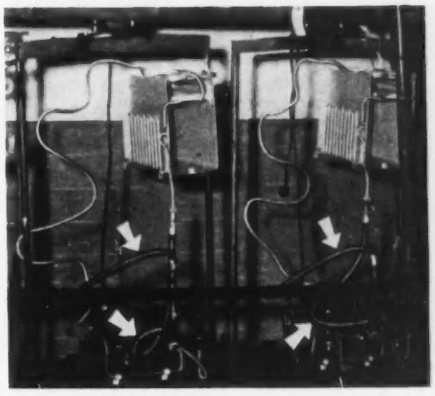
wherever connectors must move...

American ANACONDA

FLEXIBLE METAL HOSE AND TUBING



Sandwich Maker: Sheets of plywood are bonded under heat and pressure. Heat for this Mesco hot-plate press of the Harbor Plywood Corp., Aberdeen, Wash., is provided by steam carried to the 21 platens in ½" I.D. American Seamless Flexible Bronze Tubing with single bronze braid.



Dry Fact on a Cold Subject: Before installation, every Norge household refrigeration unit is dehydrated by high vacuum in a drying oven. American ¼" I.D. Seamless Flexible Bronze Tubing connects each unit to the vacuum manifold. Specifications call for leakproof, corrosion-resistant tubing able to operate under 31" vacuum at an oven temperature of 280° F for 4 to 6 hours.

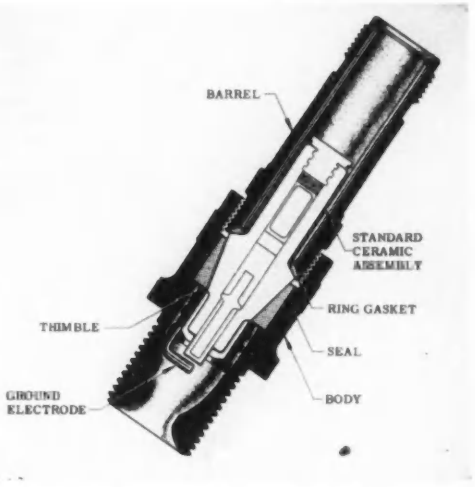
Non-Fouling Spark Plug Remains Cool in Operation

A new type of non-fouling spark plug with a wide heat range has been developed for use in automotive and aircraft engines, outboard motors and in various industrial applications.

Feature of the new plug is the use of a special design of precombustion chamber, recessed within the plug's structure to give protection to the electrodes and all other critical parts. Because the plug's ceramic is well recessed, it is said to remain relatively cooler than other plugs, and in auto and outboard plugs, under controlled testing, gasket temperatures ran as much as 20 F cooler than other plugs under normal conditions. The manufacturer gives the plugs advantages as being good starting characteristics; slow and smooth idling; less vibration; smooth and rapid acceleration with no increase in fuel consumption; and good resistance to breakdown.

Good results were obtained in the following tests: dynamometer tests, knock tests, endurance tests with high oil consumption, in aircraft with fuel containing five times the normal amount of lead, use with bad piston rings and cylinder, and in outboard motors.

The recessed chamber gives the plug good flame propagation, and produces a jet-action flame that tends to spurt out of the chamber, with the explosion well developed by the time it gets into the cylinder. Fuel is ignited efficiently, and a complete and uniform burning of fuel in the cylinder is said to result. The plug is built from conventional materials, with no platinum and no unusual



type of ceramics, designed for automatic screw machine production, with close tolerances limited to assembly fits.

Boeing Airplane Co., Seattle, Wash.

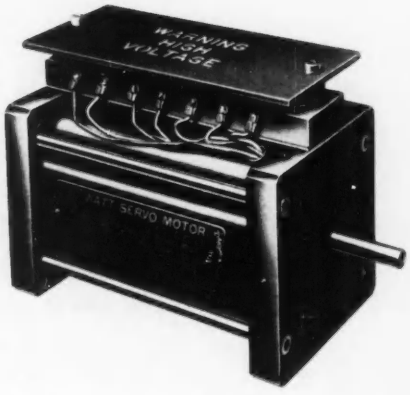
Servo Motors Have High Torque-to-Inertia Ratio

Designed for servo systems requiring sensitive and continuous control of the load, low-inertia servo motors are available in high or low-voltage ratings. The high-voltage motors, designed to operate directly from the plates of a vacuum-tube amplifier, are suited for servo systems where space is limited. Eliminating the output transformer results in a saving in amplifier space and overall weight. The low voltage motors are recommended for use with servo amplifiers having output transformers.

All the low-inertia servo motors feature the smooth iron rotor, which gives: a reduced rotor diameter (the 10-watt diameter is 0.665 in.); a reduced overall weight; elimination of cogging because there are no rotor slots. With the torque directly proportional to the control voltage, the high voltage servo motor develops a high torque, and causes a quicker correction. Tests on the low-inerta motors indicated increasing torque when the motor was driven at reverse speed.

No cut-off switches are required on the low-inertia motors. They can remain stalled indefinitely with full voltage applied to both windings. The motors also offer a high torque—to inertia ratio, and a hight torque efficiency.

The 10-watt low-inertia, low voltage servo motor is available in 60 cycles or 400 cycles. The 60 cycle unit will deliver 11 watts at 1,800 rpm. It has a minimum locked rotor torque of 15 oz-in., and a minimum no load speed of 3,500 rpm. Designed for 2 phase operation, it



may be used single phase with a 6 in. fd capacitor. The 400 cycle unit will deliver 14 watts at 4,200 rpm.

Other available sizes are ½, 1½ and 5 watts. Special medium inertia motors come in 1/20, and 1/50 hp sizes.

Ford Instrument Co., 31-10 Thomson Ave., Long Island City, N. Y.

CONTINUED ON PAGE 218

ATLAS CONVEYOR SELECTS

QUAKER CONVEYOR BELTING

For Longer Service... Tougher Hauls

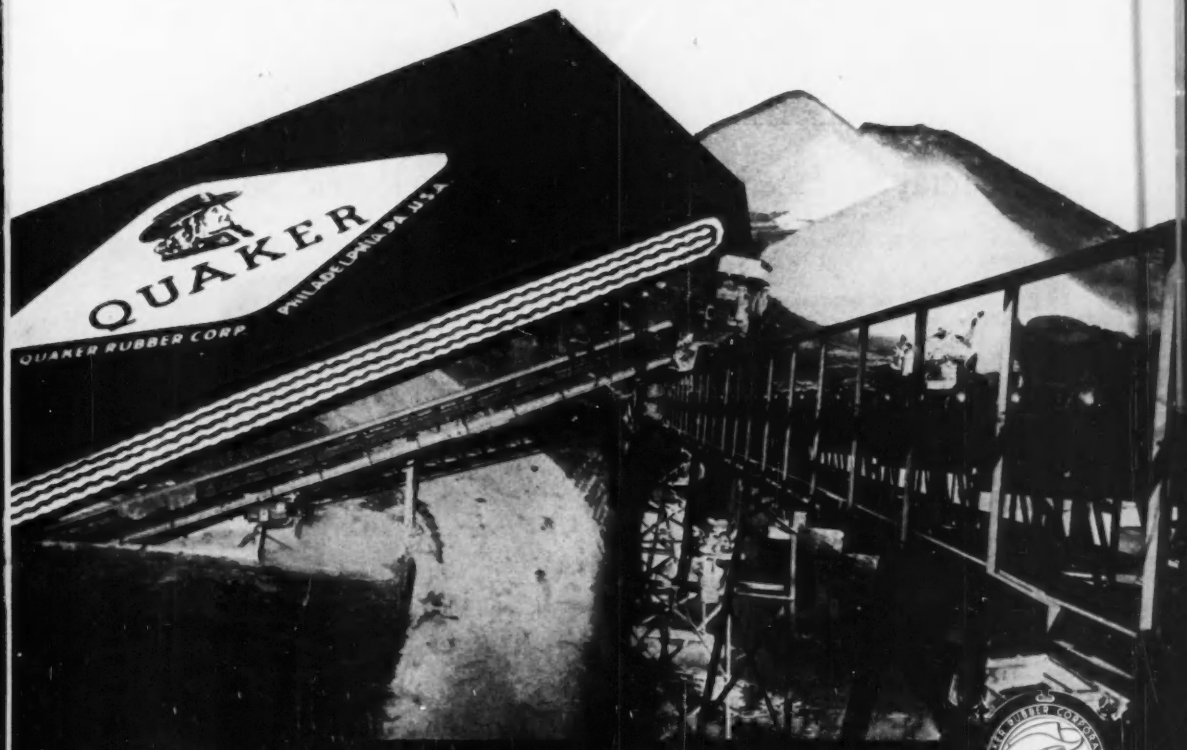
Border to border . . . coast to coast Atlas Conveyor Company, leading producer of stationary and portable conveyors, selects and recommends Quaker Conveyor Belting. Installed on all types of Atlas Conveyors Quaker belts prove their long-lasting "wearability."

Quaker Conveyor Belting is fabricated from prime selected duck with friction covers of scientifically compounded, long-lasting rubber. It is built to resist weather, shock, abrasion and flexing . . . is service-proved to give extra wear and top performance on the toughest jobs.

Whatever your needs for original equipment or replacement maintenance — transmission belting, hose or packings — there's a Quaker product that will provide long service and high production at low cost. For complete data on the Quaker line of Pre-tested Products write for the new General Catalog.

TO MAKE BELTS LAST LONGER . . . GET THIS C M P

Informative folders, booklets and charts available on how you can get more production out of industrial rubber products. No cost or obligation.



QUAKER RUBBER CORPORATION

DIVISION OF H. K. PORTER COMPANY, INC.

PHILADELPHIA 24, PENNA. BRANCHES IN PRINCIPAL CITIES

Metallizing Guns Spray at High Speeds

Two new metallizing guns have recently been produced that are expected by the manufacturers to reduce machine part repair and salvage costs 85 to 90 percent, making 25 to 30 year corrosion protection of equipment and structures available at a lower cost. The new guns, the Metco type 4E for machine element work, and the type 5E for corrosion protection coatings are said to develop the highest spraying speeds yet available in guns designed for hand-held operation. At the same time, the new guns provide almost automatic operation, since they incorporate a jet siphon principle in the gas head which automatically compensates for variations in gas pressure as high as 10 lb, and provides a steady, unvarying flame which produces uniform coatings at lower cost than previously possible. The new guns also incorporate automatic control of wire feed which compensates for kinks in the wire, and reel stand drag. The metco type 4E gun is designed to spray all wires from 20 B&S gage to $\frac{1}{8}$ in. in any metal, carbon steels, stainless, Monels, bronze, at speeds up to 40 percent faster than previous models. The type 5E is specifically designed for high speed spraying of the softer metals, such as zinc and aluminum, for protection of equipment and structures against corrosion for periods ranging from 20 to 30 years. The 5E gun sprays 3/16 in. wire and will deposit as much as 55 lb of zinc per hr, aluminum 15 lb per hour. The guns may be mounted for use on a lathe or other machine in production line work, or may be used in hand operation.

Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City, N. Y.

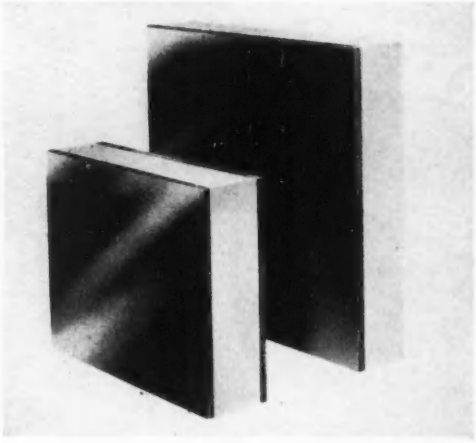
Metal Surfaced Fluorocarbon Dielectric Sheets

Chemelec Multi-Bond is the trade name applied to the new series of metal surfaced dielectric materials. The dielectric materials include pure fluorocarbon resins (teflon, kel-F), and mixtures of fluorocarbon resins with various other materials, such as asbestos, mica, fiberglass, glass, ceramics, quartz, zero-plast, calcium fluoride or calcium silicate, depending on the characteristics desired.

The metal surfaces available on any of the dielectric materials, include aluminum, boron carbide, copper, alnico, monel, lead, mumetal, solder, tin, magnesium, iron, steel, Molybdenum, nickel, nichrome, zinc, bronze, brass and the precious metals.

Sheets may be metallized on one or both surfaces. Standard thicknesses of dielectric material range from 0.030 to 1.50 in., and of the conducting metal surface from 0.004 to 0.25 in. The thickness of the multi-bond area ranges from 0.008 in. to a homogeneous mass.

The bonding of metals to pure or filled fluorocarbon resins is done by a special method. The bond structure is mico-crystalline in nature and gradually changes from pure dielectric to pure metal. The surface metal finish is applied by electro deposition or other conventional means. Due to the elastic properties of the fluorocarbon plastic and the interlocking nature of the bond, chemelec multi-bond has no acute strain point due to unequal rates of thermal expansion as with glass-to-metal or ceramics-to-metal seals. Also the resiliency of the plastic permits the chemelec multi-bond to withstand severe mechanical shock and vibration.



Chemelec multi-bond has been used for fabricating moisture proof printed electronic circuits. Standard size sheets are 8 by 8 in., 12 by 12 in., 24 by 24 in., and 36 by 36 inches.

U. S. Gasket Co., Fluorocarbon Products Div., Camden 1, N. J.

CONTINUED ON PAGE 220

YOUR HELP IS NEEDED

to get in the

DORMANT SCRAP

At current steel production rates, 50% MORE SCRAP is needed than in the peak year of World War II. The shortage is so real that steel company representatives are calling on every company in the country to find ways of relieving the situation.

Here's How YOU can help

1. Take a fresh look at your own plant scrap and salvage activities.
2. Call in your dealer—sell your scrap—*NOW!*

WAD 3886

Contributed in the National Interest by

ALLEGHENY LUDLUM STEEL CORPORATION

Henry W. Oliver Building · Pittsburgh 22, Penna.

Strain Tester Features Additive Weight Loading

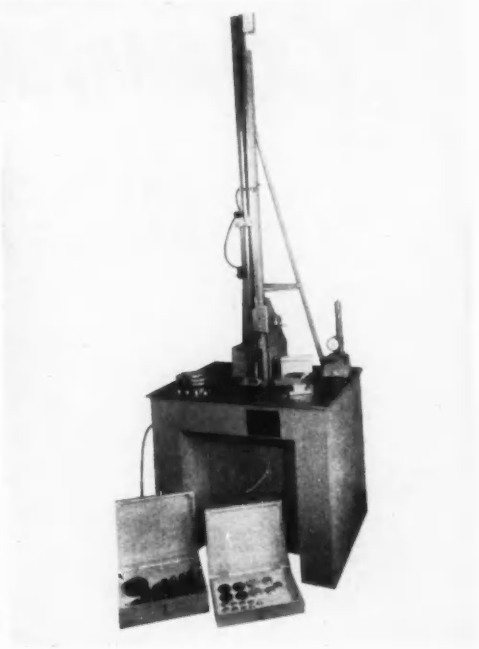
A strain tester is now being produced which performs elongation tests on rubber and other high elastomers in accordance with methods developed by the National Bureau of Standards.

The advantage of the new strain tester is said to be its method of additive weight loading, which is simple and positive. Selection of the additive weights is accomplished mechanically, without the use of electrical circuits, which are subject to mal-functioning under the climatic conditions common to rubber producing areas. The positive mechanical selection is illustrated in the accompanying photograph of the base. The operator simply gages the specimen for thickness, then turns the additive weight control hand wheels so that the numbers appearing in front of the pointer are numerically the same as those observed on the thickness gage. The additive weight control hand wheels turn the shafts shown at left, which rotate the additive weight trays by chain and sprocket drive. This positively positions the correct combination of weights over the pins of the additive weight holder.

There are four sets of additive weights, a set for each stress range: 50, 100, 200 or 400 lb per sq in. These are arranged in numbered positions in trays. Each set consists of 18 additive weights arranged in the two circular trays in the base of the machine, and a fixed weight positioned separately, below the additive weight trays.

The test performed by this instrument is the standard test for determination of strain, expressed as a percentage of the original sample gage length under known and constant unit stress. Samples of uniform width and length are die-cut from the sheet of material to be tested. Upon the sample is superimposed a gage length of 10 centimeters by means of visible markings. The sample is then stressed by loading with fixed additive weights, as previously described, to produce unit values of 50, 100, 200 or 400 lb per sq inch. Thus loaded, with the designed weights, the sample is suspended in a free static condition for a sufficient period of time to permit satisfactory dimensional stability to be reached, and allow accurate measurement.

At the conclusion of the interval of rest, the elongation is measured and compared with the original gage length.



As indicated in the illustration, the machine contains all weighting mechanisms housed in the base, and is designed so that all controls and observations are available to the operator while comfortably seated. For convenience, all electrical equipment is localized so that a single source of current is all that is required for operation of the unit.

Scott Testers Inc., Providence, R. I.

Small Relays Developed For Aircraft

Another type of miniature relay recently was introduced for aircraft equipment. This relay, designated Type MH, is available in 2, 4 and 6 pole, double-throw and has been developed to meet the requirements of the USAF specification MIL-R-5757.

The relay will withstand aircraft vibration loads of 10 G's and shock loads of 30 G's of 10 millisec duration, and is hermetically sealed for operation to 70,000 ft.

Nominal coil voltage is 26.5 v d-c. Due to the heat dissipation of the relay, the coils will withstand overvoltage of 23 percent for 8 hr without damage. These relays will operate at 18 v d-c or less after exposure to any of the stated conditions of voltage and ambient temperatures, and will release at 13 v d-c. Minimum power requirements at room temperature is less than one watt.

Contacts are rated at 2 amps noninductive at 28 v d-c for life expectancy of over one million operations. The contact circuit resistance has been reduced to a low value for hermetically sealed relays, measuring less than 0.02 ohms from terminal to terminal.

Dimensions are as follows: 6 pole, $1\frac{3}{16}$ in. dia; 4 pole, $1\frac{1}{32}$ in. dia; 2 pole, $\frac{7}{8}$ in. dia. For minimum chassis area, seated height for all three is $1\frac{1}{2}$ inches. Operating range for standard type MHB is —55 C to +85 C, and for high temperature Type MHA is —65 C to + 200 C, according to the manufacturer.

The units are tested for circuit discontinuity under impact with an electronic device having a response time of 1 microsecond.

Allied Control Co., 2 E. End Ave., New York, N. Y.

CONTINUED ON PAGE 222

From Bumper to Tailgate . . .

N-A-X HIGH-TENSILE STEEL

Reduces Deadweight and Increases Durability

The widespread use of N-A-X HIGH-TENSILE steel in transportation equipment emphasizes two vital characteristics of this high-strength low-alloy steel.

1. *Strength with less deadweight.* N-A-X HIGH-TENSILE steel reduces deadweight . . . of great importance in transportation equipment and military vehicles.
2. *Exceptional durability.* N-A-X HIGH-TENSILE steel, with its high strength and toughness, has proved greater resistance to fatigue and impact at normal and sub-zero temperatures. Its inherent structure and composition greatly reduce the effects of abrasion and corrosion.

The response of N-A-X HIGH-TENSILE steel to severe cold-forming operations and its excellent weldability by electric arc or resistance, atomic hydrogen or heliarc, and all other processes, are added important characteristics of N-A-X HIGH-TENSILE steel.

The "Eager Beaver"

The use of low-alloy, high-strength steels in military equipment assures longer life with less deadweight.

GREAT LAKES STEEL CORPORATION

NATIONAL STEEL CORPORATION

Laminated Washer Of Metal and Neoprene

Weath-R-Seal washers are a combination of a metal washer and a neoprene composition washer which gives a two way seal. The product is applicable in corrugated sheet building erection, automotive and appliance assembly, sheet metal ductwork, metal-to-porcelain assemblies and many other applications, where a metal and a compressible washer are used separately for sealing, surface protection or vibration absorption. The single unit is said to reduce work motion, speed and assure correct assembly, and reduce inventory.

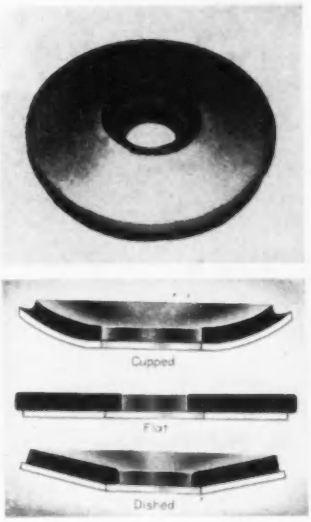
The three principal styles available are the dished, flat, and the cupped. The shape of the dished washer is actually a flat cone, with the face varying from 10 to 20 deg from the flat. The O.D. and the I.D. of the metal layer is slightly larger than that of the neoprene composition layer. When the neoprene is extruded under the pressure of the tightened fastener a two-way seal is effected, sealing both the outer edge of the washer and the fastener shank. Good for corrugated sheet erection, it is used with nails, bolts, screws and fasteners. The flat washer has the O.D. of the neoprene composition, is larger than that of the metal, and the I.D. is smaller, giving a good seal of the shank and the outer edge. The cupped washer has the O.D. of the neoprene less than that of the metal washer, with the I.D. the same.

Other specifications are: the standard size of the washers range from $\frac{3}{8}$ in. to 3 in. O.D. Larger diameters can be supplied.

Metals used are aluminum, brass, copper, galvanized or carbon steel, plated or stainless steel, as required.

Neoprene composition ranges in thickness from $1\frac{1}{16}$ in. to $\frac{1}{4}$ in., as specified. Standard thickness is $\frac{1}{16}$ in. to $\frac{3}{32}$ in.; for heavier than $\frac{3}{32}$ in. the tolerance is plus or minus $\frac{1}{64}$ in.

Fabricated Products Co., West Newton, Pa.

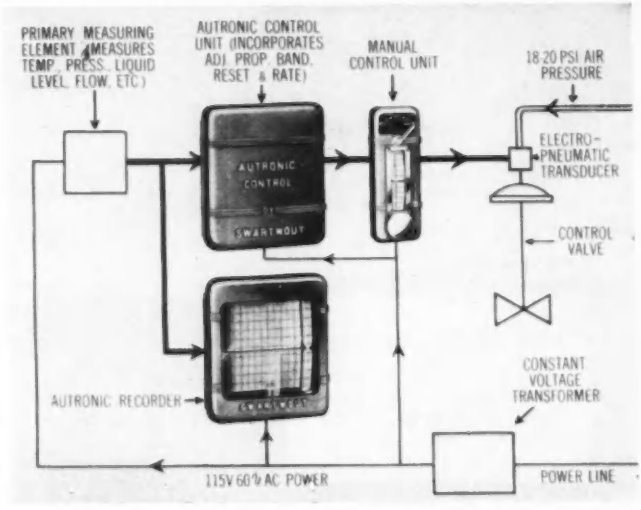


Automatic, All Electronic Control System

A new automatic all-electronic instrumentation and control system, known as the Autronic Control System, has been developed for use in chemical and food processing plants, refineries, petrochemical installations, industrial power plants and central stations, and for measuring and controlling process variables such as temperature, pressure, level, and flow.

The autronic control system consists essentially of three basic units: primary sensing element; autronic control unit; and final control element.

The primary sensing element generates a voltage which is directly proportional to any change in the process variable. This voltage, always within the same range regardless of whether temperature, pressure, flow or level is being measured, is transmitted to the autronic control where it is continuously modulated by electronic means. The autronic control unit then transmits the resulting d-c to the final control element which may be either electrically or pneumatically operated. The system is powered by 115 v 60 cycle a-c.



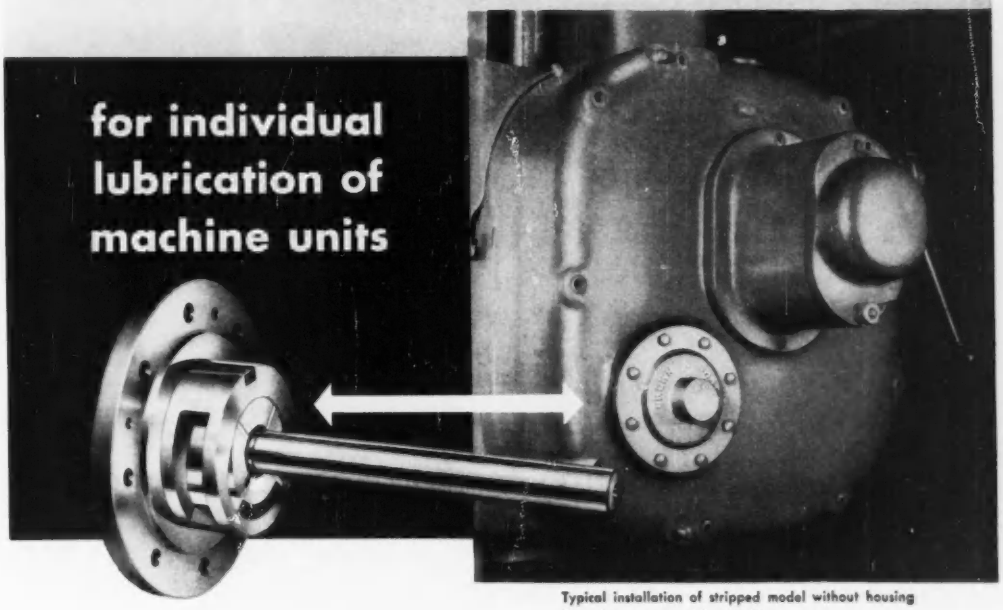
Since transmission of information throughout the system, from primary element to final element, is by electrical means only, there is no transmission lag. Also, there are no slide wires to initiate control action.

The Swartout Co., 18511 Euclid Ave., Cleveland 12, Ohio

CONTINUED ON PAGE 224

COMPACT AUTOMATIC REVERSING VANE PUMPS...

for individual lubrication of machine units



Typical installation of stripped model without housing in modern metal-working machine.

You get modern appearance when you equip machines with stripped models of Brown & Sharpe Automatic Reversing Vane Pumps. They're extremely compact . . . yet sturdily built for continuous, trouble-free service.

Brown & Sharpe *Stripped Models with housings* (Nos. 8022, 8062, and 8102) are very easily installed, particularly where internal discharge and suction ports are not readily incorporated in the machine design or when outside piping is desirable. *Stripped Models without housing* (Nos. 8023, 8063 and 8103) wherever installed, offer minimum projection from machine surfaces. Designed for use as integral parts of machines where suction and discharge ports can be incorporated in machine castings.

Fully-automatic reversing with unidirectional flow is a feature of all these pumps. Sizes available: 2½, 5 and 11½ g.p.m. at 0 lbs. pressure and at 1140 rpm. These and other features are fully described in Bulletin. Write Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

WE URGE BUYING THROUGH THE DISTRIBUTOR

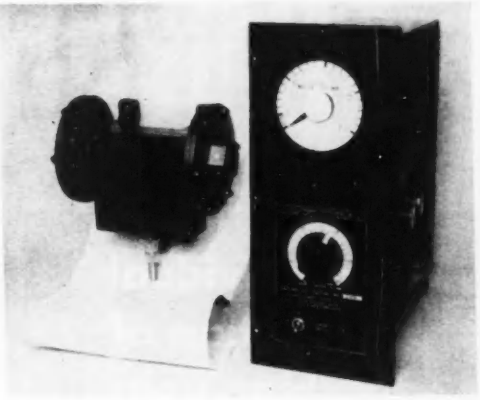
Brown & Sharpe B·S

Multi-Purpose Electronic Control Unit

The electronic differential pressure indicating control unit is an electronic system, consisting mainly of a sensing element and an indicating control unit, designed to indicate and control the differential pressure between a volume of corrosive gas and a surrounding gas. The sensing element will note a signal according to the variation in the differential pressure which will produce a visual indication on the indicating control unit located at a distance of approximately 100 to 250 feet from the sensing element. The indicating control unit is made up of an amplifier; an oscillator; a vacuum tube voltmeter; a voltage doubler; an electronic relay; and a power supply unit.

In addition to being a visual indicator, it is a two position controller which will close a set of contacts when the differential pressure drops below a predetermined value. A manual control on the indicating control unit is provided so that the pressure differential necessary to operate the contact points may be varied. This control system, with modifications of the sensing element, can be adjusted to be used to indicate linear movement, and may be used to indicate pressures, temperatures, accelerations, and forces, if the equipment is calibrated in terms of the particular sensing element used.

The unit pictured, is used to indicate and control differential pressures of plus 5 in. of water column to minus 20 in. of water column. On-off differential of the two position controller is 1 in. of water column. The particular unit shown is operated on 115 v 60 cycles power.



The sensing element consisting of an iron core, is constructed of special materials, such as, teflon and monel to withstand the action of corrosive gases.

Coral Designs, Div. of Henry G. Dietz Co., Long Island City, N. Y.

Manometer Measures Low Pressure Difference

Operating from a noble metal thermopile, using the same principles of the air velocity and vacuum measuring instruments, this highly sensitive Electronic Manometer and Flowmeter has no glass or plastic tubes, and contains no fluids.

The operation of the manometer is not difficult. The two taps on the gage tube are connected to the two points at which the pressure difference is to be measured. To use the instrument as a flowmeter, the tube is placed directly in the line for low flow rates or connected to pressure taps on two sides of a calibrated orifice for high flow rates.

The Electronic Manometer will measure low pressure differences and has a dual range of 0.001 in. to 0.1 in. and 0.1 in. to 2 in. water. The instrument may be used for direct indications or attached to a recorder. The calibration and accuracy of the instrument is not affected when long extension cables are used from the gage tube to the meter. This permits remote installation of the gage tube.

Hastings Instrument Co., Super Highway & Pine Ave., Hampton 10, Va.

"RUSTSHIELD 2", a phosphatizing compound which changes steel and iron surfaces to rustproof, absorbent non-metallic areas, offers an ideal base for the retention of lubricating oils. Metal parts treated with this compound are said to retain lubricating qualities longer than smooth steel surfaces. Rubbing and sliding surfaces of precision parts with close tolerances are not affected by the phosphate treatment. Rustshield meets U. S. Army specifications 57-0-2c, type II class A. Octagon Process, Inc., 15 Bank St., Staten Island 1, N. Y.

CONTINUED ON PAGE 226

to turn a production problem into a **LIGHT** *subject—*

make it of BRASS

These eighteen copper alloy parts, illustrated approximately half-size, go into the military flashlight produced by The Niagara Searchlight Corporation of Buffalo, N. Y. Only copper alloys can provide the complete range of physical properties needed and still maintain low manufacturing cost.

If, like this military flashlight, your product consists of parts calling for certain physical properties . . . if it must be born of a streamlined manufacturing budget and still be an aristocrat in quality—then you'll find no metal more versatile than brass.

Although almost all of these 18 metal parts differ in their function, copper alloys supply the required properties — high electrical conductivity, resilience, excellence as a plating base, strength, immunity to rust and resistance to corrosion. And to all these properties, singly or in combination, add the characteristic that brass can be fabricated more economically by more methods than any other metal.

With all these properties, brass has no equal for its usefulness as a manufacturing metal. Brass is the metal on which your designers, cost analysts, production men and sales department will be most likely to agree.

Our Technical Department will gladly suggest the copper alloy best suited to your product and manufacturing methods. Just write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

51107

ANACONDA® *the name to remember in* **COPPER BRASS BRONZE**

Heavy Duty Master Switch Is Dustproof

A redesigned dustproof master switch featuring a new cast-aluminum cover and up to five adjustable stops has been designed for heavy-duty installations, and application on large equipment such as steel mill type cranes.

The new aluminum cover offers good protection for the switch interior from dust, dirt, and accidental blows. Weighing only one-third as much as the previously used cast-iron cover, it is easy to remove for inspection and normal servicing of the switch interior.

Adjustable stops on the switch provide for any combination of from one to five points of movement of the operating handle in either clockwise or counterclockwise direction. An open end wrench is the only tool required to make this adjustment.

Standard equipment includes a ball and rod handle, but four other types of operation are also available: ball and rod handle with off-position latch operated from a thumb lever on the handle; ball and rod handle with auxiliary electrical switch operated from a thumb lever on the handle; ball and rod handle with spring return mechanism built into the handle; and an under-lever mechanism.

The new switch is fully interchangeable in size and mounting with former types produced by this company, and all wearing parts, such as contacts, are the same.

General Electric Co., 1 River Rd., Schenectady 5, N. Y.

High Capacity Selenium Rectifier Power Units

New custom made a-c to d-c rectifier power conversion units have been developed for high current and voltage capacities of 50 kw and larger. The manufacture of the extra large selenium rectifier incorporates a vacuum process used by this company. The use of these larger cells permits the use of few parallel elements for a given d-c output which keeps the weight to a minimum.

Some of its advantages are: smooth uniform selenium film permitting thicker deposits of selenium; low voltage drop in the conducting direction and a minimum current leakage in the blocking direction; shock and vibration proof; light weight for given power output; requires no warm-up period; high current capacity with good voltage regulation; capable of withstanding current overloads.

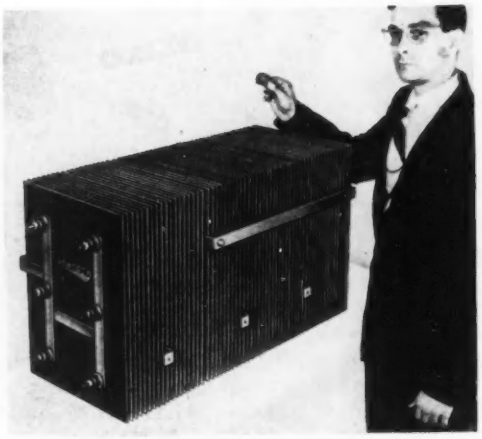
Normal loads require only natural ventilation of air past the cells (convection cooling). These selenium rectifier stacks are made up of individual cells assembled on an insulated stud. Electrical connection is made to the surface of the cells by a pressure spring contact washer. The cells are spaced apart by washers to permit cooling.

Forced ventilation (fan cooling) will permit higher current rating of the cells. Approximately 150 linear feet of air per minute pass the cells will permit 2 times the normal rating, and 250 ft 3 times normal.

For high overloads of short duration the rectifiers may be immersed in oil for cooling or to protect them in destructive atmospheres.

The selenium rectifier cells are available in 16 standard sizes, with the smallest, cell A, being 1 in. by 1 in., and the largest, cell X, being $12\frac{3}{8}$ in. by 16 inches. The use of the larger cells permits stacks requiring fewer parallel elements for a given d-c output. Maximum ratings are 26 rms volts per cell.

Syntron Co., 240 Lexington Ave., Homer City, Pa.



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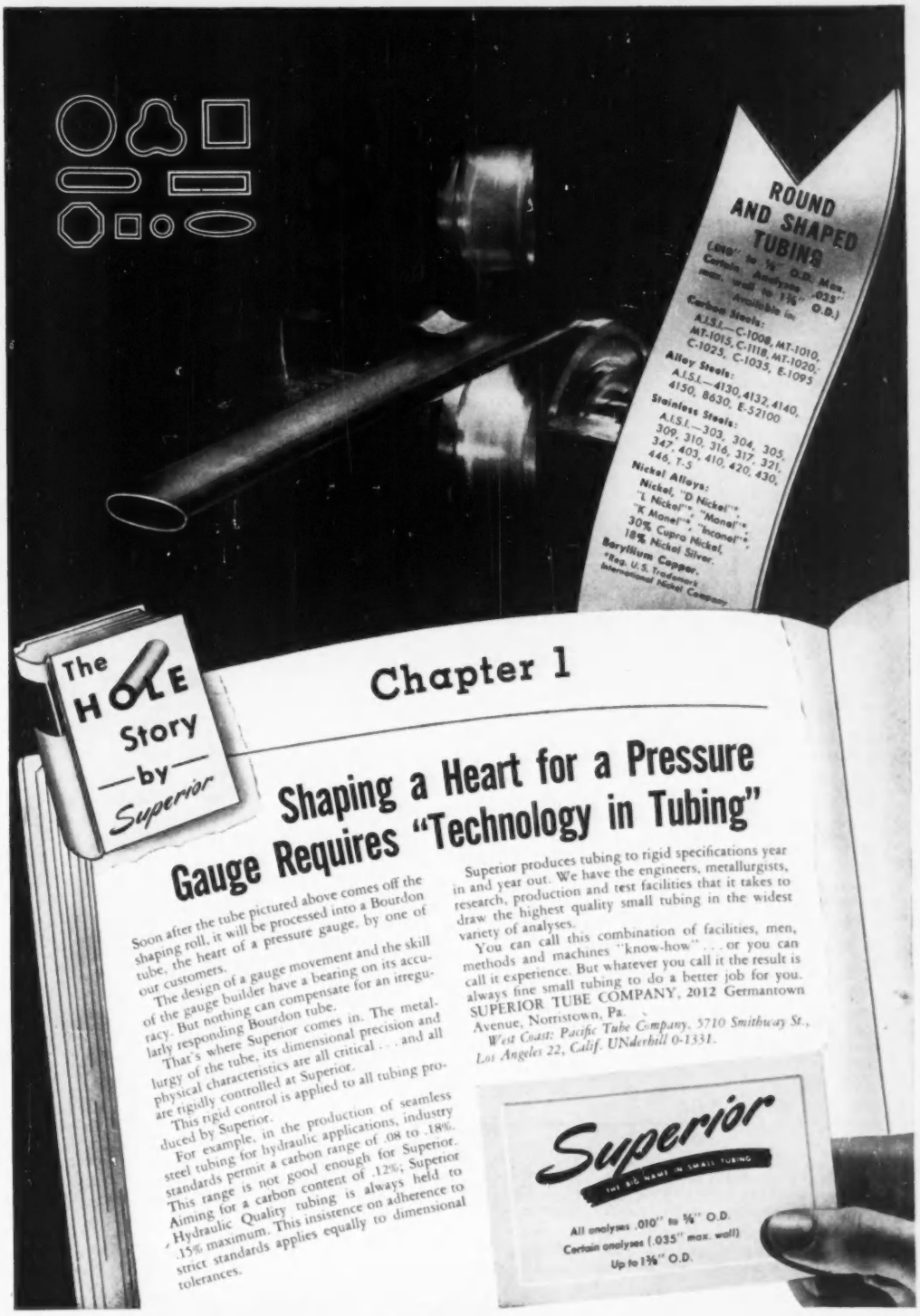

ROUND AND SHAPED TUBING
(.010" to ⅝" O.D. Max. Certain Analyses .035" max. wall to 1⅜" O.D.) Available in
Carbon Steels:
A.I.S.I.—C-1008, MT-1010, MT-1015, C-1118, MT-1020, C-1025, C-1035, E-1095
Alloy Steels:
A.I.S.I.—4130, 4132, 4140, 4150, 8630, E-52100
Stainless Steels:
A.I.S.I.—303, 304, 305, 309, 310, 316, 317, 321, 347, 403, 410, 420, 430, 446, T-5
Nickel Alloys:
Nickel, "D Nickel"*, "L Nickel"*, "Monel"*, "K Monel"*, "Inconel"*, 30% Cupro Nickel, 18% Nickel Silver.
Beryllium Copper.
*Reg. U.S. Trademark International Nickel Company
The HOLE Story —by— Superior
Chapter 1
Shaping a Heart for a Pressure Gauge Requires "Technology in Tubing"
Soon after the tube pictured above comes off the shaping roll, it will be processed into a Bourdon tube, the heart of a pressure gauge, by one of our customers.
The design of a gauge movement and the skill of the gauge builder have a bearing on its accuracy. But nothing can compensate for an irregularly responding Bourdon tube.
That's where Superior comes in. The metallurgy of the tube, its dimensional precision and physical characteristics are all critical . . . and all are rigidly controlled at Superior.
This rigid control is applied to all tubing produced by Superior.
For example, in the production of seamless steel tubing for hydraulic applications, industry standards permit a carbon range of .08 to .18%. This range is not good enough for Superior. Aiming for a carbon content of .12%, Superior Hydraulic Quality tubing is always held to .15% maximum. This insistence on adherence to strict standards applies equally to dimensional tolerances.
Superior produces tubing to rigid specifications year in and year out. We have the engineers, metallurgists, research, production and test facilities that it takes to draw the highest quality small tubing in the widest variety of analyses.
You can call this combination of facilities, men, methods and machines "know-how" . . . or you can call it experience. But whatever you call it the result is always fine small tubing to do a better job for you.
SUPERIOR TUBE COMPANY, 2012 Germantown Avenue, Norristown, Pa.
West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331.
Superior
THE BIG NAME IN SMALL TUBING
All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall)
Up to 1⅜" O.D.

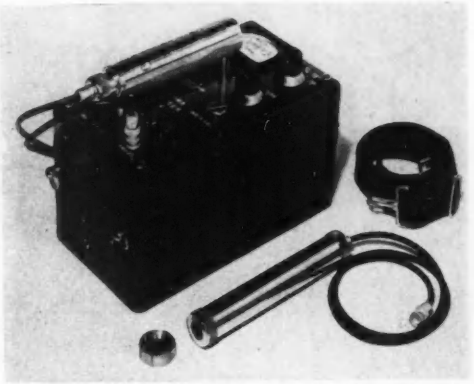
Survey Meter Has Optional Alpha Detector

A new Alpha Beta Gamma Survey Meter with an optional probe for alpha detection and many new design features, has been developed for use as both a radiation dosage rate meter and for civil defense use as a low-level contamination monitor. In this respect the SU-5A has proved helpful in the laboratory for checking glassware, benchtops, hands, coats, etc., and in locating relatively small amounts of spilled radiochemicals. In addition, the instrument can be used to locate radium, for monitoring the amount of radiation from isotope shipments and the measuring of dosage rates from stored radioisotopes, to ascertain whether adequate shielding has been employed.

The new instrument is waterproof, lightweight, battery operated and is provided with two sets of scale ranges, enabling readings to be made in both mr/hr and CPM. For scale ranges of 0.02, 0.2, 2.0 and 20 mr/hr, corresponding CPM ranges of 100, 1,000, 10,000 and 100,000 are provided.

Other new features include a case mounted radioactive source for checking overall operation, a redesigned instrument handle which holds the probe when it is not in use, and the availability of an optional alpha probe.

The P-17 Side Window Probe is equipped with a captive beta shield which permits the separate measurement of gamma radiation in the presence of beta radiation. The



P-18 End Window Probe is equipped with a thin mica end-window G-M tube and is used to permit monitoring of low energy beta emitters, as well as alpha particles.

* More information may be obtained from the manufacturer.

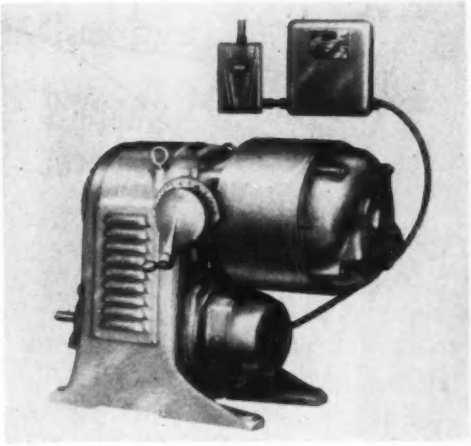
Tracerlab, Inc., 130 *High St., Boston* 10, *Mass.*

Accurate, Controlled Braking of Motors

Fast, controlled braking of the varidrive motor is now possible with the addition of a Warner type ICB brake, mounted directly on the variable speed shaft, eliminating transmission of the braking action through the belt. Good for inching or jogging, the ICB offers instant, shockless operation without noise and produces a constantly increasing torque during stopping. Containing few parts, the ICB has a mechanical movement of only 1/16 in. Unlike the solenoid type brake, its frictional force is controlled directly by the magnetic action of the brake. Adjusted with accuracy, the braking torque, once set, is permanent, an important aid in applications demanding accurate regulation. For installations requiring diversified braking torques, adjustment is easily made through a knob-controlled rheostat. Designed to dissipate a high rate of heat, the ICB offers stability of operation with long, trouble-free service.

Adaptable to both varidrives and the varidrive-syncro-gears, produced by this company, this brake is d-c actuated with low power requirements; max 25-35 watts. Power conversion units are used where a-c voltage is supplied.

U. S. Electrical Motors, Inc.,
200 E. Slauson Ave., Los Angeles 54, *Calif.*



A NEW CAPACITOR has as its main feature a section that is always in the exact center from one end to the other, thus providing good dielectric strength. A completely molded unit, the capacitor has good over-all insulation, high humidity resistance, and no wax to melt and run off. Used with temperatures up to 150 C. Dumont Electric Corp., 308 Dykman St., New York 34, N. Y.

CONTACT MATERIAL FOR SWITCHES is now available in the form of metal slugs brazed into strip stock and positioned to form the desired part. The material is a combination of precious and base metal with good wear resistant qualities. The material may be used on rotors and in switches. The D. E. Makepeace Co., Attleboro, Mass.

—CONTINUED ON PAGE 230

DIE CASTINGS

BY

Stewart

41 YEARS OF SERVICE TO INDUSTRY

DESIGNING

Die Casting Die Designing is an art requiring an extensive knowledge of metals, metal-working techniques, engineering skill, and wide experience. Our designers are craftsmen with many years' direct contact experience in application and end use requirements.

Services available to you at Stewart's

- Designing
- Die Making
- Engineering
- Metallurgical Control
- Most modern Die Casting Equipment
- Complete machining, polishing and assembly facilities

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Division of Stewart-Warner Corporation

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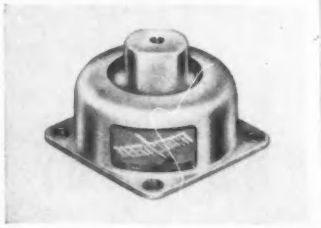
SHOCK and VIBRATION NEWS

BARRYMOUNTS FOR ASSURED CONTROL OF SHOCK AND VIBRATION

NEW ALL-METL BARRYMOUNTS

for Unusual Airborne Applications



These new Barrymounts provide the aircraft and electronic engineer with a vibration isolator designed to meet the unusual temperature and environmental conditions encountered in high-altitude, high-speed flight. Employing no organic materials, these mountings are not subject to temperature influences that may affect the performance of other mountings.

ALL-METL Barrymounts offer a wide load range with uniform performance. They have a natural frequency of about 7½ cycles per second, with low horizontal stiffness for maximum isolation of horizontal vibration. Transmissibility at resonance is only 4½. There is no snubber contact nor resonance carry-over when ALL-METL Barrymounts are vibrated at government-specified amplitudes.

These mountings are designed especially for unusual military conditions. They meet the vibration requirement of JAN-C-172A, MIL-E-5272 (USAF), and MIL-T-5422 (BuAer). For details of sizes, ranges, and construction of unit mounts and bases using ALL-METL Barrymounts, see catalog 509.

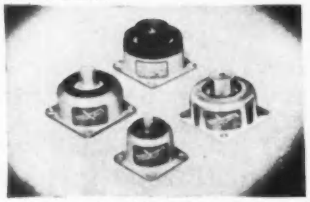
FREE CATALOGS

- 502 – Air-damped Barrymounts for aircraft service; also mounting bases and instrument mountings.
- 509 — ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504 — Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 — How to cut maintenance costs by using Barrymounts with punch presses.

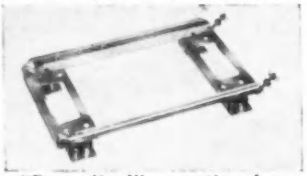
"RUGGEDIZED" BARRYMOUNTS AND MOUNTING BASES

Now Available to Meet Shock Requirements of AN-E-19

Barry vibration isolators and mounting bases are now available in "ruggedized" construction, to withstand the severe shocks of arrested landings in aircraft carrier service and of crash landings. These units are tested to meet the shock-test requirements of Specification AN-E-19, for the equipment sizes listed in JAN-C-172A.



"Ruggedized" Barrymounts are available in both the air-damped type and the ALL-METL type. Air-damped Type 770R covers load ranges between ¼ lb. and 9 lbs. Air-damped Type 780R covers load ranges between 4 lbs. and 35 lbs. ALL-METL Type 6600R covers load ranges between 4 lbs. and 35 lbs. Type M-112R covers ranges between 2 and 10 lbs.



"Ruggedized" mounting bases, equipped with Barrymounts of the above types, are available in standard JAN sizes (JAN-C-172A) and in special sizes to meet customers' requirements. A conspicuous advantage of these "ruggedized" Barry bases is the gain in strength of the base framework itself — beyond JAN requirements — achieved with very little increase in weight for loads up to 60 lbs. by design modification of standard JAN bases. For greater loads, the "ruggedized" Barry bases are of stainless steel instead of aluminum. Write for data sheet.

THE BARRY CORP.

730 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

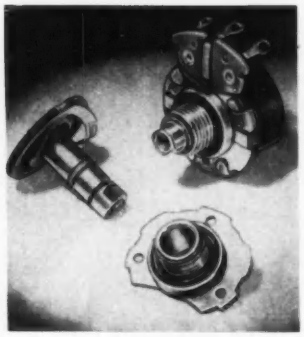
SALES REPRESENTATIVES IN

New York Rochester Philadelphia Washington Cleveland Dayton Detroit Chicago Minneapolis St. Louis Seattle Los Angeles Dallas Toronto Atlanta

Waterproof Control Withstands 6-Foot Head Pressure

A new series of waterproof controls are available in a wide range of resistances and wattages, and have been especially designed for use in military assemblies.

A rubber "O" ring is used on the shaft creating a water tight seal which



will stand pressure equivalent to a six foot head of water. A similar rubber ring is used on the mounting surface of the bushing performing the same function as the shaft ring seal.

The rings are of rubber compound of special design to meet high temperature requirements, and are resistant to oils and greases.

Clarostat Mfg. Co., Inc., Dover, N. H.

Surface Type Thermostat For Water Heater

Chief feature of the surface type electric model W water heater thermostat is its constant pressure contact mechanism which maintains full contact pressure right up to the instant the contacts open; thereby reducing arcing to a minimum. This feature is said to assure a fast break and lengthen contact life. It is made possible through a design, which enables the bimetal element to move in the direction opposite to the movement of the contact.

This new thermostat used for both primary and secondary control is a small and compact unit, measuring only $2\frac{7}{8}$ in. high by $1\frac{5}{8}$ in. wide by $1\frac{3}{4}$ in. deep. It is particularly suited for table-top model water heaters, where space is at a premium. Mounting brackets are provided, which allow the thermostat to be mounted either to the heating element screws or to the side of the tank. Mounting stresses are all taken by a strong box shaped metal

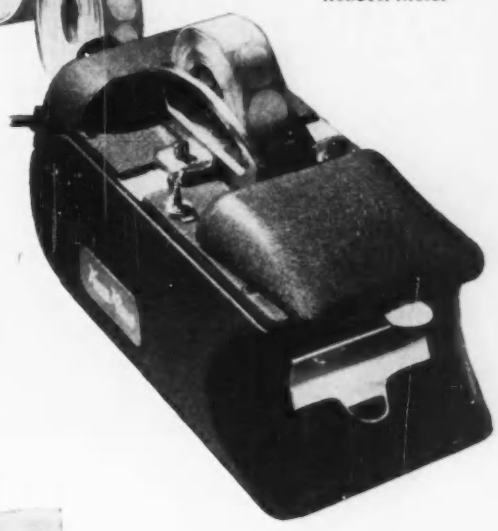
New Label Dispenser uses a BODINE MOTOR

Bodine Type NSE-11R Speed Reducer Motor

The Avery Adhesive Label Corp. needed a motor that would provide stable operation over a wide speed range and varying loads...on a stop and go basis through rheostat control...for their new Kum-Kleen Label Dispenser. Labels were to be fed through the dispenser at a rate that varied from 6 to 150 lineal inches per minute. Even when operating at its lowest speed, the machine would be required to stop and start, yet accelerate quickly and accurately.

Working as a team, Bodine's local representative and factory engineers developed a special motor winding and control circuit that not only met all customer requirements, but was capable of start and stop operation, without stalling, at speeds as low as 1 to 2 lineal inches per minute.

Why not let Bodine know-how provide you with motors best suited to your particular application? Nearly half a century of experience insures satisfaction. It will pay you to consult Bodine engineers.



REASONS WHY

"Our new Kum-Kleen Label Dispenser is now using a Bodine Motor and we feel impelled to write you this complimentary note on two particular counts: 1—The first has to do with the obvious quality of Bodine motors over those used previously. The appearance, power, quietness of operation and standard performance characteristics of your motor have added measurably to our product. 2—The second is the truly astonishing performance characteristics which your local representative designed into these particular motors."

R. S. Avery, President
Avery Adhesive Label Corp.
Monrovia, Calif.

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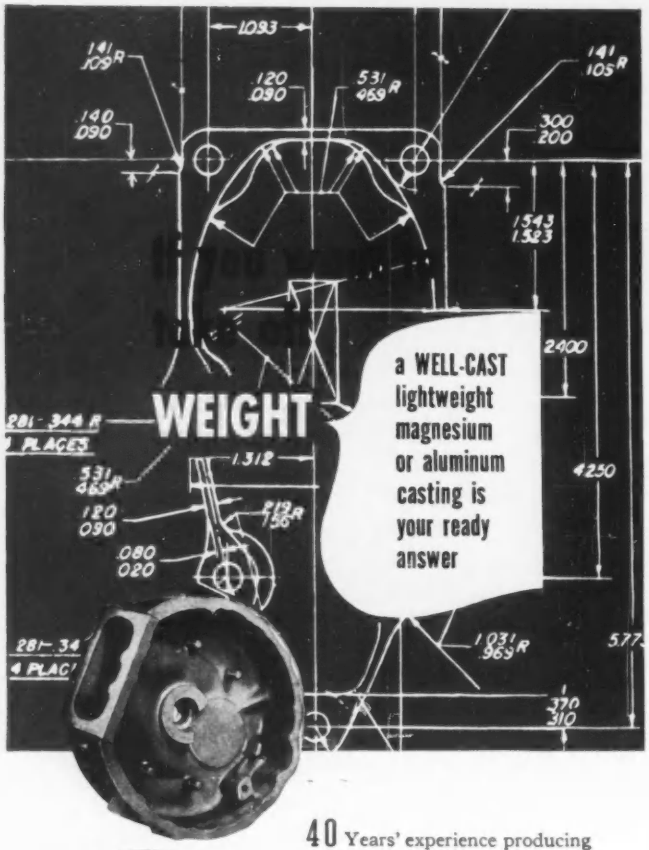
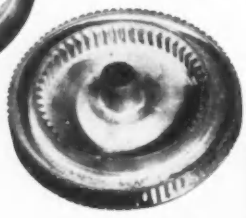


40 Years' experience producing quality lightweight castings for the aircraft, textile, pneumatic tool, automotive, domestic appliance, and other diversified industries everywhere.



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Ampco Bronze Castings

THE WELLMAN BRONZE & ALUMINUM CO.

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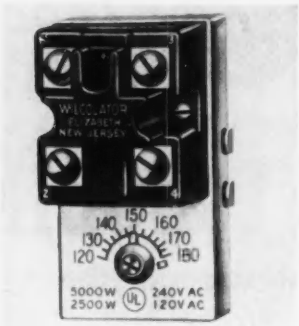


base and are not transmitted to the bakelite casing or contact mechanism. This thermostat may be mounted interchangeably with most other surface type electric water heater thermostats.

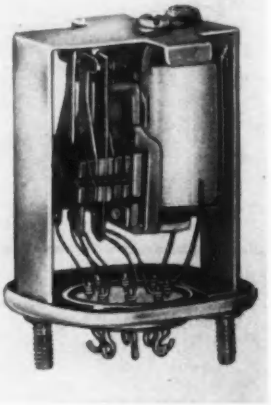
In order to facilitate testing in production and service, it is possible to very easily cold check the operation of the thermostat and heater circuit by merely turning the pointer counter clockwise below the 120 F mark. New safety features include terminal blocks extended $\frac{1}{4}$ in. above terminals and electrical spacings, considerably in excess of Underwriters minimum requirements.

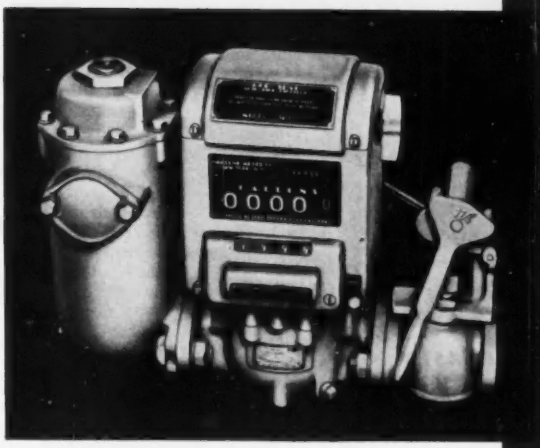
Wilcolator Co., Elizabeth, N. J.

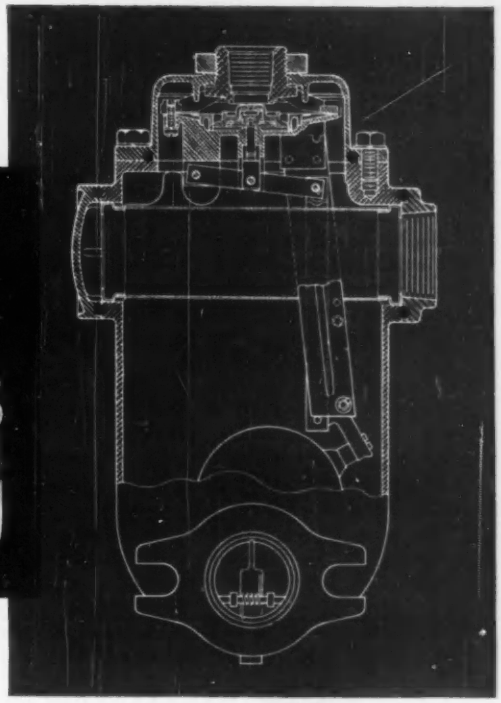
Midget Relays Are Vibration Tested

The new line of midget telephone type relays, known as the series 80, is a compact, multiple contact unit with vibration proof characteristics. Designed to meet the requirements of armed service applications, the pile-up arrangement used reduces the over-all space volume.

The contacts used are palladium,







TIP...

FOR THE DESIGNER

Always Ready for Action With...

LINEAR "O" RINGS

The drying out of gaskets in meters stored for even short periods is a common trouble. It is costly, too!

The makers of Neptune Compact Meters for tank trucks licked this problem with Linear "O" Rings . . . eliminated the need for disassembling and re-assembling meters before they could be put into service. Exhaustive tests showed that no leaks occur even well beyond standard test pressures. And years of service *on the job* confirmed test results.

This is another example of what can be accomplished with Linear "O" Rings in advanced engineering and design. The substitution of Linear "O" Rings for conventional compression gaskets in Neptune Meters provided a perfect seal with *metal-to-metal* contact between flanges. This means an end to the need for periodic checking and tightening of bolts . . . less down-time and repair expenses due to gasket failure . . . simplified and much less expensive inspection procedures. Many a sealing problem becomes no problem at all when Linear "O" Rings replace conventional gaskets!

Linear "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and "Silastics" . . . are molded in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes and special shapes. Precision molded under rigid laboratory control, Linear "O" Rings may be depended upon for continuous and lasting service.

It will pay you to consult Linear during the design stages of your sealing applications.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

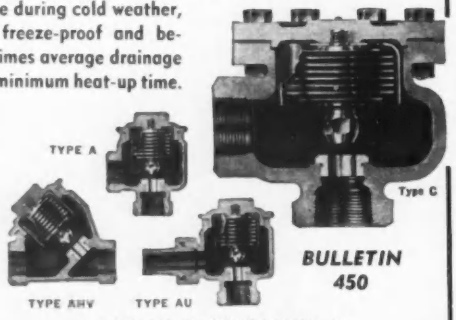
LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

NICHOLSON MAKES

Freeze-Proof Steam Traps

for Every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Sizes ¼" to 2"; pressures to 225 lbs.



BULLETIN 450

200 OREGON ST., WILKES-BARRE, PA.

W. H. NICHOLSON & CO.

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If your product calls for any of these roller chain sprockets as diagramed, the new Sewall Stock Sprocket Catalog can save you time and money. *May we send you a copy?*

Sewall sales engineers will welcome your inquiry on any type of custom-built cut tooth gears . . . racks . . . all types of sprockets.

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E. B. SEWALL MANUFACTURING CO.
696 Glendale St. • St. Paul 4, Minnesota

rated at 3 amps non-inductive load at 24 v d-c, or 115 v, 60 cycles. Silver contacts rated at 5 amps are also available. The relays are available with octal base, sealed or unsealed, snap-on dust covers, and hermetically sealed containers. Also equipped with the modified type AN 3106-20-27P sealed connector.

On the open type relays, the coils are varnished-impregnated to resist high humidity conditions. All ferrous parts are treated to pass salt spray tests.

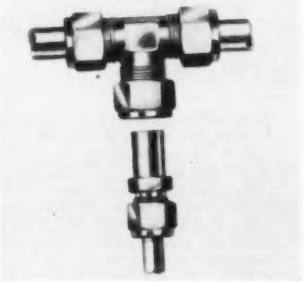
The contact arms are rivet assembled, with a contact pressure spring under the rivet head to assure good contact at all times. Standard pile-ups are 2 form C and 4 form C. Other contact arrangements not exceeding a total of 12 springs are available. The longest relay, that with the sealed connector, is 3¼ in. high.

Signal Engineering & Mfg. Co., 154 W. 14th St., New York, N. Y.

Reducer Fitting Joins Different Sized Tubing

Consisting of a body, two ferrules and a nut, the new Swagelok reducer fitting is designed to permit different sizes of tubing to be joined easily. The two ferrules, plus the threaded chuck inside the nut, clinch tight around the tubing wall and give a leakproof seal.

The illustration shows a ½ in. all tube tee and a ⅜ in. reducer. No preparatory steps are necessary on the tubing. Assembling is as follows: the tubing is inserted into the reducer, and one and one-quarter turns are applied to the reducer nut to complete the first assembly. The reducer is next inserted into the fitting and one and one-quarter turns are applied to complete the assembly. In this manner the instrumentation and process piping lines may be reduced to the required diameter both on the run and on the branch. The completed fitting is said to be torque-free and leakproof.



The reducer fittings are available in

Exact precision alignment is secured with sleeve bearings more readily than with any other type. Bunting Cast Bronze Bearings pressed into the housing and bored in line assure the utmost in precision alignment. When alignment is one of your problems utilize this outstanding advantage and consult the Bunting Engineers whose experience is at your disposal. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in Principal Cities.
BUSHINGS
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BRONZE BEARINGS
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and liked it!

This Ward Leonard Vitrohm bracket terminal resistor was installed in the fluorescent lighting system of the new subway cars for three important reasons.

First, it could withstand the wear and tear of constant vibration and shock of starts and stops.

Secondly, it could be installed faster and easier in very limited space.

In the third place, although these resistors last indefinitely, they must be readily replaceable in case of accidental damage.

These subway cars run on 600 volt D. C. The builder provided pre-wired terminal studs. By using a bracket terminal resistor it was possible to combine mounting and electrical connection in one simple, fast installation.

That's Ward Leonard "result-engineering"—problems turned into perfect performance by the proper selection or adaption of electric controls. Write for Vitrohm Resistor Catalog, Ward Leonard Electric Co., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD
ELECTRIC COMPANY
Result-Engineered Controls Since 1892
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

brass, aluminum, steel, stainless steel, and Monel in sizes ranging from $\frac{1}{8}$ in. to $\frac{7}{8}$ in. O.D. The fittings are said to hold heavy or thin wall tubing equally well, and are made for use with tubing of brass, aluminum, steel, stainless steel, Monel and plastic.

Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio

Rubber Seal Operates With Pressures to 5,000 Psi

A small dam type seal made of Hycar oil resistant rubber has been devised to seal off tremendous pressures which may leak around the threads in oil well tubing.

Called the Stoneseal, the new type dam seal is approximately the size of an eraser on a common lead pencil. In installation a hole is drilled completely through the oil well tubing to allow gas pressure from the inside of the tubing to force the Hycar rubber seal into the thread of the coupling. The seal actually comes into contact with pressures in the range of 5,000 lb psi, but has withstood pressures up to 12,000 lb psi in tests conducted by the engineering firm. Stoneseals have been in service at temperatures up to 250 F without any appreciable failure.

Hycar oil resistant rubber, has extreme resistance to high temperatures, oxidation and aging, oil and grease, and abrasion. In addition Hycar remains flexible in actual service at low temperatures.

B. F. Goodrich Chemical Co., 324 Rose Bldg., Cleveland 15, Ohio

Tube For High-Speed Digital Computers

A twin triode tube, designated as GL-5844, and designed for use in moderately high-speed digital computers, may be widely used in "flip-flop" service in binary system calculators.

For computer applications, the GL-5844 directly replaces the type 6J6 and requires one-third less heater power than that tube. The GL-5844 requires only 300 milliamps heater current. More than one-half kilowatt of power can thus be saved in a 600 tube computer. Plate output at zero-bias conditions exceeds that of the 6J6 because of higher perveance.

Of particular interest is the fact that the cutoff voltage between triodes balances within a one-volt limit. A special cathode design prevents failure of a tube to function after periods of non-conduction while biased to cut-off.

For average characteristics and typi-

cal operation the plate voltage is 100 v; cathode bias resistor is 470 ohms; amplification factor is 27; the approximate plate resistance is 7950 ohms; the transconductance is 3,400 micromhos; plate current is 4.8 milliamps. The seated height is $1\frac{7}{8}$ in.; the dia is $\frac{3}{4}$ in., and the base is miniature button 7-pin, E7-1.

General Electric Tube Div., Schenectady 5, N. Y.

Boil-Proof Glue Offers Saving in Resorcin

A new resorcin-phenol adhesive called Casophen LT-68, an improved modification of LT-67, has been developed to meet military specification MIL-A-379A. A boil-proof glue that can be cured at intermediate temperatures, it can be stored for a full year without sacrificing any of its working properties. The glue contains less than 20 percent resorcin, which offers a saving in this material.

Resistant to boiling and outdoor exposures, the glue is used in laminated frames; keels and other ship parts; ribs for artic shelters, and army field furniture and skis.

Borden Co., 350 Madison Ave., New York 17, N. Y.

Glass Mold Sticking Relieved

A new lubricating treatment prevents the sticking and sagging in molten glass molds which leads to a washboard surface. This is accomplished by treating the mold surfaces with a dispersion of colloidal graphite in oil. The results are said to be less scrap, improved lustre of the finished product, and a reduced necessity for cleaning the mold. The graphite particles in a petroleum oil carrier are microscopic in size. After evaporation of the carrier the thin film remaining is unaffected by high temperatures, and has a low coefficient of friction.

Acheson Colloids Corp., Port Huron, Mich.

4,000 Psi Pneumatic Check Valve

Designed for efficient, dependable operation, the manufacturers claim their pneumatic check valve to be the only one available for use with 4,000 psi air, and hydraulic pressures up to 5,000 psi. Maximum free flow is 7 lb per minute. Maximum pressure drop through valve is 100 psig at 7.0 lb per min air flow with an air inlet pres-

. . . A-C or D-C . . . multi-pole construction . . . many more uses

Now you can get fast, positive, consistent operation on a *wide range* of load and control circuits . . . from the finest design of solenoid contactor on the market.

This new Size O a-c contactor brings Ward Leonard's line of solenoid contactors into the 15 ampere range. And it comes with as many as 5 poles. Double-break silver contacts may be interchanged to form normally-open or normally-closed contacts as desired.

Operating coils are interchangeable with Size 1 contactor coils. Available also with d-c "power plants".

Write for Bulletin 4458. WARD LEONARD ELECTRIC CO., 63 South Street, Mount Vernon, N.Y. Offices in principal cities of U. S. and Canada.

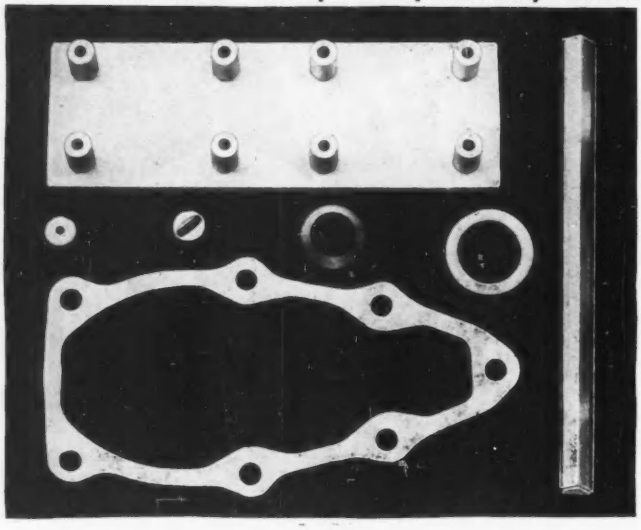
WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls Since 1892

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

SILICONE RUBBER Parts

RESIST EXTREME HEAT, COLD, FLUIDS, GASES



Silicone rubber is a solution to problems involving rubbery properties at abnormally high and low operating temperatures. Under these conditions it performs successfully beyond the scope of any known rubber or rubber-like materials, and meets the requirements of extreme temperature applications in the aviation, automotive, electrical, refrigeration and original equipment manufacturing industries.

At extreme temperatures −100°F to +500°F Silicone rubber parts remain resilient, with improved compression set. General qualities include; excellent stability after long exposure to ultraviolet rays, prolonged weathering, fungus growth, many oils and a variety of chemicals; excellent dielectric properties, and water repellency; stainless; odorless; bonds to metal.

Seals, gaskets, O-rings, packings, diaphragms and numerous parts can be produced from Silicone stocks.

Acushnet
PROCESS COMPANY
New Bedford, Mass., U. S. A.

Rubber Handbook sent on request

Address all communications to 768 Belleville Ave., New Bedford, Mass.

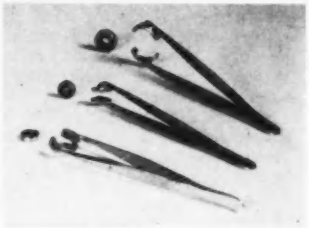
sure of 150 psig max. Leakage in reverse flow direction will not exceed 200 cu in. of free air per min at 4,000 psi. The proof pressure of this check valve is 9,200 psi.

This free flow check valve is manufactured of stainless steel. The outer cylinder is a standard AN 6249-6 envelope. Both ends of the unit are in accordance with AND 10056 for $\frac{3}{8}$ in. tubing. It weighs 3.4 ounces.

Bobrick Mfg. Co., 1839 Blake Ave., Los Angeles 39, Calif.

Miniature Ball Bearing Tools

New, special type tools have been developed for handling instrument ball bearings during inspection, cleaning and relubrication operations. These new tools are essentially special tweezers for use on bearings having



bores from $\frac{3}{32}$ to $\frac{1}{2}$ in., and can be furnished in two models, one for gripping the bearing by the inside race and the other for the outer race.

These tools are useful for assembling bearings into equipment, and will help avoid the corrosive effects of finger handling of bearings.

The Baker Co., Maplewood, Maine

Purge Meter Formed Of Acrylic Plastic

A plastic purge meter that eliminates packing glands and glass parts has been developed with the tube and all piping connections being bored from a block of acrylic plastic. Flow adjustment may be made with a flow-mite needle control valve, an optional feature, which may be installed on either the inlet or outlet position of the metering tube.

The mite purge meter comes in four sizes with a range of 0.01 to 54.0 gal per hr of water and 0.2 to 216 cu ft per hr of air. The rate of flow is visibly indicated by the position of a spherical float in the metering tube.

Two standard models of the mite are currently available for metering flows where high accuracy is not required. The model R 2,000 meter has

CHASE BRASS AND COPPER WIRE

has the fine temper that makes better wire products

You can, quite literally, bend Chase brass, copper and bronze wire to your will because it has precisely adjusted temper, excellent ductility and great tensile strength.

For coining or embossing, heading and extruding, heading and drilling, making of rivets, screws, springs you'll find a just-right Chase wire. It comes in six standard annealed and eight standard drawn tempers.

But no matter which Chase wire is used, you can be sure that it will have accurate dimensions, true roundness, freedom from physical defects, beautiful uniformity of surface, texture and color.

Write for *FREE* booklet—"Chase Cold Heading Extruded Brass and Copper Alloy Wire" giving physical and fabrication properties, applications, weights per 1000 feet and feet per lb.

Chase BRASS & COPPER

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CHASE 75th ANNIVERSARY 1876 1951

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Boston	Detroit	Minneapolis	Providence	
Chicago	Houston†	Newark	Rochester†	(†sales office only)
Cincinnati	Indianapolis	New Orleans	St. Louis	

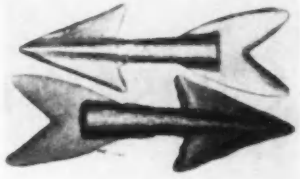
etched reference marks for approximate flow indication, while direct flow readings are made with the model S 2000 meter, which has standard calibrations for either air or water. Both models are safe for pressures up to 100 lb per sq in. and max working temperature of from 180-200 F. A standard bezel is obtainable for flush panel mounting of either model.

Brooks Rotameter Co., Lansdale, Pa.

Compound for Barrel Finishing Metals

A special purpose chemical is available for barrel finishing brass, bronze, copper, gold and silver stampings, castings, and machined and drawn parts. Offered under the trade name Blue Magic compound No. 1 double strength, this compound is a concentrated paste for use in very small quantities, and is said to yield uniform metallic colors and finished in extremely short time cycles.

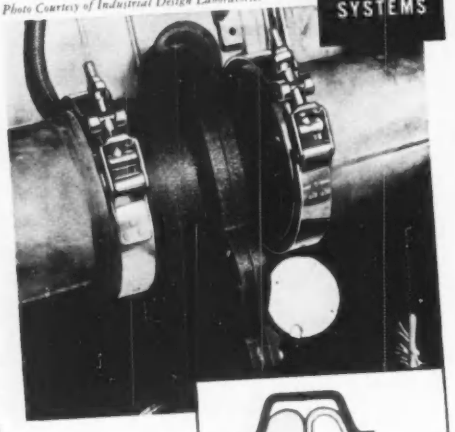
Blue Magic No. 1 is said by the manufacturer to be good for finishing either with or without media, and with selected non-ferrous media for roughing, deburring, cleaning and finishing in a single operation. Recommended quantities are only 4 oz of compound for finishing runs in a 32 in. x 30 in. tumbling barrel at high water level. As a cutting compound in deburring op-



ENGINEERS NOTEBOOK

HEATING SYSTEMS

Photo Courtesy of Industrial Design Laboratories



MARMAN

V-Bands and integral welded flanges simplify duct coupling on Globemaster

An ideal arrangement for coupling iris control valve in by-pass heating duct of the Douglas C-124 Globemaster II is achieved with a standard Marman V-Band Coupling and integral welded flanges. This is but one example of many diversified applications where standard Marman couplings and flanges provide the right combination of strength, light weight and positive seal, plus production and maintenance advantages of the patented "Quick Coupler Latch."

Save Cost, Time and Weight with Marman

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- Radio Quiet
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- High Insulation Resistance
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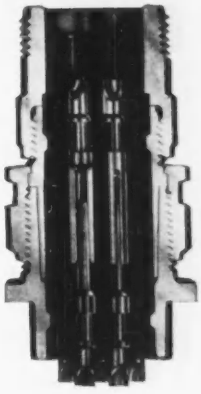
- Fewer Parts than any other Connector
- No additional solder required

The ability to carry maximum currents with only a minimum voltage drop is an outstanding characteristic of Bendix Scinflex Electrical Connectors. This important feature is only a part of the story of Bendix success in the electrical connector field. The use of Scinflex dielectric material, an exclusive Bendix development of outstanding stability, increases resistance to flash over and creepage. In temperature extremes, from −67°F. to +275°F. performance is remarkable. Dielectric strength is never less than 300 volts per mil. All in all, no other electrical connector combines as many important exclusive features as you will find in Bendix Scinflex connectors. For higher efficiency in your electrical connectors be sure to specify Bendix Scinflex. Our sales department will gladly furnish additional information on request.

PLUS



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High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS
High current capacity . . . Low voltage drop.

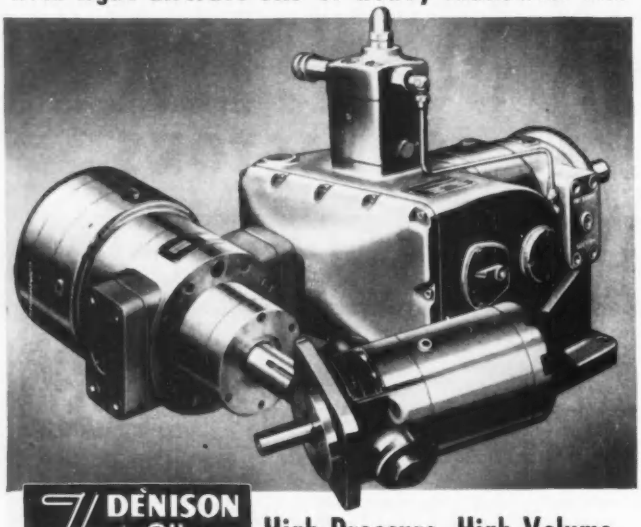
SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

Bendix

SCINTILLA MAGNETO DIVISION of

HIGHER EFFICIENCY

with light aircraft oils or heavy industrial oils



DENISON HydrOILics **High-Pressure, High-Volume**

PUMPS for All Circuit Needs to 5000 psi

Here's high-pressure, high-volume efficiency on a wide range of ruggedly built pumps. They feature complete hydraulic balance that eliminates the use of thrust bearings . . . simplified construction that requires fewer parts . . . exclusive axial piston design that assures longer, maintenance-free service, *and many other advantages.*

Denison HydrOILic Pumps include constant-volume and variable-volume types for all circuit requirements up to 5000 psi, with volume delivery capacities ranging from 2 to 35 gpm. Variable-volume types are available with stem, handwheel, or compensator control. A choice of face, flange or foot mountings is offered on all of these pumps.

Increasing demands for modern high-pressure systems, and the resulting need for compact hydraulic units built to withstand long, hard high-pressure operation, have led to the wide preference for Denison Pumps.

The tougher the job, the quicker you discover the advantages of Denison HydrOILic Pumps, developed through 25 years of experience in designing and building oil-hydraulic equipment *exclusively.* Put these advantages to work in your hydraulic circuits — for either intermittent or continuous service.

Write today for full details on pumps to fit your needs.

The DENISON Engineering Co., 1157 Dublin Road, Columbus 16, Ohio

DENISON PUMPS

erations, only 1 oz to 2 oz of compound is needed at low water level in the barrel.

The illustration shows a before and after view of a bronze casting deburred and finished with the compound. Advantages claimed are economy, fine finish, uniform metallic colors, and greatly reduced time cycles on all operations.

Blue Magic Chemical Specialties Co., 2135 Margaret St., Philadelphia 24, Pa.

Glass Cloth Wrapped Pipe Joint

Duro-Joint, a new type of wrapped joint for Haveg and other resin-base pipe, is composed of a spiral wrapping of glass cloth and lecite acid, and alkali-proof furan resin cement using a special technique. It is said to be equal in strength and chemical resistance to the pipe itself. The Duro-Joint may replace the flange type joint which is subject to corrosion, and also may be used to repair broken pipe or to armor porcelain or stoneware.

The Duro-Joint can be made in the field without the use of heat or special equipment. The joints were tested without failure under hydro-static pressure pulsating rapidly from 0 to 350 psi. They were then placed under 100 lb steam pressure and while hot, the pressure was released and the joint immersed in water at 60 F. The Duro-Joints were unaffected by this shock treatment.

Electro Chemical Engineering & Mfg. Co., 750 Broad St., Emmaus, Pa.

Lead-Free Aluminum Solder Rod

A new lead-free aluminum solder rod that melts at 400 F and flows at 450 F, can be applied with ordinary soldering irons, and give performance equal to that of higher melting point solders which must be applied by torch.

This new rod is identified as No. 37 aluminum solder rod and, while made especially for soldering iron application, it can be applied by any indirect heating method. It is used with No. 37 Brazaloy Flux made by this company. Properly applied, it will withstand pressures of 1,000 psi. No. 37 is for work on all types of aluminum except 24ST and also for work on aluminum to dissimilar metals. In wide application on electric and neon signs, television and radio chassis, lighting fixtures and electronic equip-

ment and instruments, it is said to have proved to have good matching color and good corrosion-resistance.

All-State Welding Alloys Co., Inc., 273 Ferris Ave., White Plains, N. Y.

Adhesive Backed Felt Tape

For use in sealing against dust, wind, fumes, rattle and squeak deadening, thermal insulation, and for vibration and shock cushioning, a reinforced felt tape known as Kling felt has been developed with an adhesive back. Requiring no paper or separation material between layers, it can be applied in a short period of time.

This felt is available in rolls from $\frac{1}{4}$ in. to 66 in. wide, and in the following thicknesses: $\frac{1}{64}$ in., $\frac{1}{32}$ in. (100 ft long), $\frac{1}{8}$ in. (50 ft long), $\frac{1}{4}$ in. (25 ft long). Also available as a cut gasket.

Products Research Co., 5426 San Fernando Rd., Glendale 3, Calif.

New Line of Attenuator Switches

A line of attenuator switches recently introduced includes 12 round, single-deck units in one- and two-pole types with up to 60 contact positions and with rotations ranging from 144 deg to 360 deg. Average resistance of the silver alloy contacts of 0.003 ohms is maintained throughout a life of upward of a million operations. Typical ratings are 1 amp at 25 v; $\frac{1}{2}$ amp at 50 v; $\frac{1}{4}$ amp at 110 v; and 0.2 amp at 220 volts.

All of the new attenuator switches are obtainable with or without detent mechanism. All have silver alloy contacts, wiper arms and collector rings. Most types can be ganged by using a square switch plate slightly larger on a side than the specified diameter of the standard round plate.

Shallcross Mfg. Co., Collingdale, Pa.

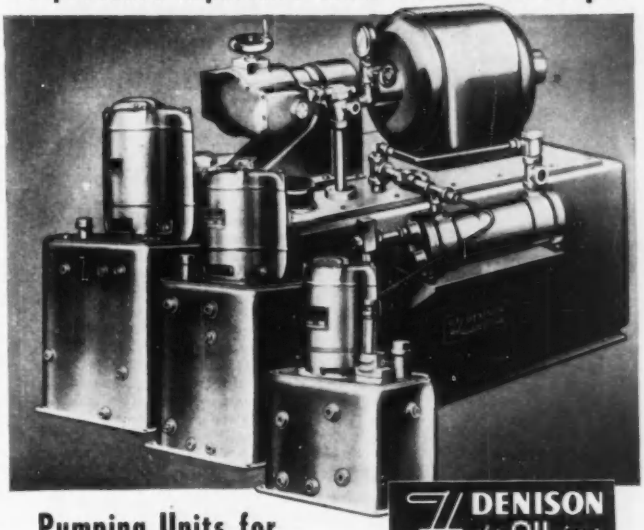
Electric Etcher Marks 15 Pieces at One Time

A new "javelin" type etcher handles up to 15 work pieces at one time, etching on hard or soft metals, flat or curved surfaces, with identifying numbers, names, trademarks or designs. Tools, gages, parts for automobiles, aircraft, engines, and machinery, as well as cutlery and other consumer merchandise may be marked.

The marking is produced by means

PACKAGED POWER

in pressure capacities from 400 to 5000 psi



DENISON HydrOILics

Pumping Units for Highest Efficiency on Every Type of Circuit

You get extra ruggedness and efficiency *plus lowest operating costs* when you select Denison HydrOILic Pumping Units. Built in 37 different models, they meet any circuit need that calls for a pressure capacity of from 400 to 5000 psi . . . for constant or variable volume operation . . . with volume control by hand wheel, stem or pressure compensation . . . volume deliveries from two to 35 gpm. Capacities of the oil reservoirs range from 16 to 165 gallons.

One of the big reasons for the fine performance records of these high-pressure, high-volume pumping units is that they are built around the famous HydrOILic axial piston pumps, described on the opposite page. These hydraulically balanced pumps have shown exceptionally high volumetric efficiencies in repeated tests made at operating pressures up to 5000 psi.

Single-panel mounting of motor, pump, relief valve, gauges and controls permits quick, easy, low cost maintenance — and adds to compact assembly that simplifies circuit arrangements. All larger series units are of horizontal design, and meet JIC standards.

You get the benefits of *proved performance* backed by 25 years of specialized experience in building oil-hydraulic equipment, when you power your circuits with Denison HydrOILic Pumping Units! Write for further information.

The DENISON Engineering Co., 1157 Dublin Road, Columbus 16, Ohio

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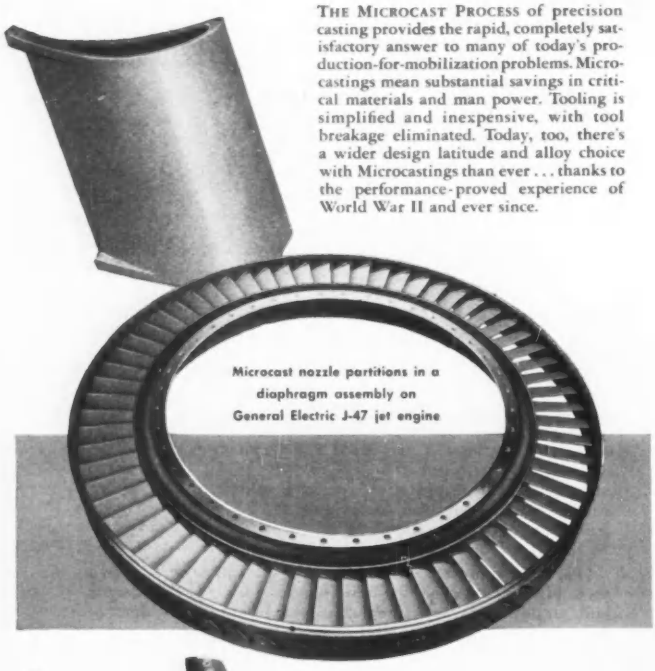

Microcast nozzle partitions in a diaphragm assembly on General Electric J-47 jet engine

Virtually every leading jet aircraft engine manufacturer uses Microcast power blading. Design engineers of these revolutionary power plants know Microcasting's outstanding advantages . . . features that may well fit into your present production program. Better write today for full information.

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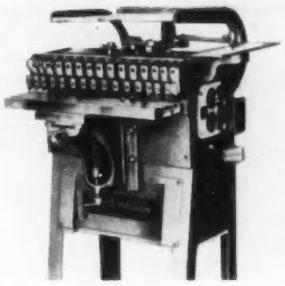

of a series of minute electric arcs, formed at the point of a rapidly vibrating electrode linked to a pantagraph. The pantagraph, is guided by a single operator.

The Javelin method offers flexibility for shape and size of work-piece, for design and depth of mark. A piece may be etched in its finished state without prior or after treatment. The manufacturers claim that the work is clean, safe, accurate, leaves no burrs, will not damage or weaken the product, and that production is faster than conventional marking or acid etching.

Engis Equipment Co., 431 S. Dearborn St., Chicago, Ill.

Tachometer Has Range to 30,000 Rpm

Called the Dr. Horn centrifugal hand tachometer, this unit has six ranges covering from 25 to 30,000 rpm, is protected against damage from over speeding, and requires a minimum of maintenance. It measures rotational, linear, and peripheral speeds regardless of the direction of rotation. Using a revolving pendulum as the measuring mechanism, the unit will operate equally well in a vertical, horizontal or slanting position.

James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

Our Defense Program Faces a Crisis

A major crisis will soon confront our defense program.

It is not a crisis in raw materials. To find enough materials, from steel to cobalt, for defense production is a serious problem. But it is one that is being solved.

It is not a crisis in manpower. Shortages of workers with special skills hamper production, but these shortages are being relieved, slowly.

It is not a crisis in manufacturing capacity. American industry's record-breaking expansion is, with very few exceptions, keeping abreast of defense needs.

The coming crisis will be one of finance. It will rise from our failure to provide the means to PAY FOR the defense program we now have under way.

A $15 Billion Deficit?

Congress has approved a defense program which is scheduled to raise *total* federal spending in the year from June, 1952, to June, 1953, to somewhere between $85 and $90 billion. Additional appropriations for more air power and atomic development, which are now proposed, would add several billion dollars.

But Congress has not approved a tax plan to match such spending. With the new levies enacted in this session, tax collections during the 1952-53 fiscal year are estimated to fall somewhere between $70 and $75 billion. That would be roughly $15 billion short of balancing the budget. If the defense program is expanded, the deficit will be that much greater.

We have not yet felt the impact of the crisis that would accompany a federal deficit of this magnitude. Federal tax collections currently are big enough to balance federal expenditures. But the defense program is scheduled to boost the annual rate of federal expenditures $25 billion in the next year.

To Meet the Crisis

By January the crisis will be clearly in sight.

Then the President will present his budget. After that, Congress must act to close the broad gap between government income and government spending. If it fails to do that, the whole defense program will be menaced by weakness in its financial foundations. That weakness might well take the form of another destructive wave of inflation.

We have three ways to meet this crisis.

The best approach, of course, is to cut unessential expenditures. That can make a real dent in the deficit. The second is to collect more

taxes. The third, and by all odds the most dangerous, is to have the federal government meet its deficit by going deeper into debt. Borrowing, which might feed inflation, can easily lead to disaster.

Near Income Tax Limits

It will not be possible to raise taxes to meet the deficit merely by increasing further the rates on corporations and on persons in the upper income brackets. Congress has about scraped the bottom of that barrel.

The Senate Finance Committee said as much in reporting this year's tax bill. The Committee reported that it had "serious doubts as to the feasibility of raising any substantial additional amounts of revenue from income tax sources." The Committee observed that recent tax legislation brings the burdens of most corporate and individual income taxpayers close to the World War II peaks, and actually carries the rates paid by many taxpayers above those peaks.

Our ramshackle federal tax system must be thoroughly overhauled in order to broaden the tax base if it is to produce more revenue—without doing much more harm than good.

The shocking fact is that no one seems ready to act along any line that might enable us to surmount the crisis.

That fact of itself aggravates the coming crisis. And next year's presidential election doesn't make it any easier to move effectively. Both parties will shrink even more than normally from backing any program that might irritate any considerable number of voters.

If we are to meet this crisis on the tax front in an orderly way, the technical work should be in progress right now. To a large extent it is being ignored.

If we are to enforce the vitally essential program of government economy, there is the same urgent need to get under way the spade work that is required.

And if—as a last miserable expedient—we decide to let the federal government drift deeper into debt, it must have a well-developed program of borrowing from individuals and other investors, such as insurance companies, rather than from the commercial banks. Borrowing from commercial banks might speedily translate the deficit into more and more price inflation. No adequate program of borrowing from savings is now in sight.

Now Is the Time

It is possible, of course, that international relations may improve sufficiently to make it safe for us to slow down the rearmament program. If that should happen, the fiscal crisis would not be so critical. But that kind of good fortune has been notably absent in recent years.

Lenin, patron saint of Communism, is quoted to the effect that to destroy a political and social system such as ours "you must debauch its money."

We shall set democracy to digging its own grave if, through our preoccupation with politics during the presidential campaign, we pave the way for further debauchery of our money.

If we really want to avert that disaster, now is the time for us to get going.

Once the crisis is full upon us, it will be too late.

McGraw-Hill Publishing Company, Inc.

NEW CATALOGS AND BULLETINS

A Reader Service To Help Keep You Up-to-Date

(1) IMPROVED CASTINGS—The International Nickel Co., Inc. Booklet, 8 pp. Describes the use of Nisiloy, which is a combination of Nickel and Silicon. Adds better machinability, toughness, resistance to wear, and reduces rejects. An alloy of 60 percent nickel, 30 percent silicon, with a balance of iron, it melts at 1,800 F.

(2) DIRECTORY—General Motors Corp. Booklet, 16 pp. Entitled "Selling to GM," this booklet is an aid to the many potential suppliers of G.M. It contains a directory of 39 GM manufacturing divisions, with a detailed listing of the civilian and defense products made by each, with an alphabetical listing of the products.

(3) INDUSTRIAL LUBRICANTS — The Alpha Corp. Bulletin 93, 8 pp. Several case histories describing the use of Molykote in various applications. Includes machine tools, dies, press fittings, high temperature lubrication, cold forming, and others. Basic ingredient is a molybdenum disulfide powder.

(4) SILICONE RUBBER RINGS—Frederick S. Bacon Lab. Data Sheet 102, 1 pp. Complete specifications on silicone rubber O-rings giving tensile strength, elongation, compression, brittle point, swell, and its suitability for use with foods.

(5) UNICLAMPS — Delta-Star Electric Co. Booklet, 4 pp. Illustrations and specifications for the five basic types of uniclamps produced. These are the quarter clamp, the half clamp, the extension half clamp, the floor flange, and the brace flange. Uses are pipe racks, frames for wire fences, handrails, and other structures.

(6) ENGINEERING EQUIPMENT — Warren Knight Co. Catalog WA-10, 56 pp. Complete with illustrations and specifications, this catalog contains a complete list of all drafting room equipment, tracing and drawing papers, slide rules, and all types of transits and levels available. Also has details on the weight slide rule, used to determine weight of various shapes of metal.

(7) SUB-FRACTIONAL HP MOTORS—Howard Industries Inc. Booklet, 8 pp. Illustrations and description of universal and d-c motors, shaded pole motors, gear reduction units, and induction motors. Shaded pole motors are available from 1/2,000 to 1/80 hp. Universal and d-c motors available from 1/1,000 to ¼ hp.

(8) PERMANENT MAGNETS—The Indiana Steel Products Co. Catalog 11, 16 pp. Information on permanent cast magnets in shapes of bars, rods, cylinders, assorted U shapes, horse shoe type, channels, rings, rotors, multiples, holding assemblies, and magnetizers. Contains illustrations and specifications.

(9) SPRINGS—The Die Supply Co. Bulletin 1951, 10 pp. An illustrated list of about 500 stock sizes, with specifications as to pressure, percentage of deflection, shape, use and weight. Also contains a list of special springs with specifications for each.

(10) TEMPERATURE INDICATORS — Manning, Maxwell & Moore. Catalog, 100 pp. Completely illustrated with colored photos, and engineering drawings of all types of the American brand glass thermometers, dial thermometers, recording thermometers, separable sockets, microsen temperature indicators and recorders, and electric indicators and recorders. Complete specifications for all types.

(11) CORED FORGINGS — National Cored Forgings Co., Inc. Booklet, 4 pp. Illustrations and description of cored forgings of brass, bronze and copper. Cross-sectional views showing close tolerances, grain structure, and how machining operations are eliminated. Tubes, valves, elbows, and traps are made.

(12) RUBBER PRODUCTS—The H. O. Canfield Co. General Catalog, 16 pp. Complete list of gaskets and grommets for all uses, automotive and aviation parts such as vibration dampeners, hose connections, bumpers, and diaphragms, electrical and appliance parts, medical, optical, and drug use, and plumbing.

(13) MIDGET RELAYS — Signal Engineering & Mfg. Co. Bulletin MTR-142, 4 pp. Describes and illustrates the series 80 line of midget telephone type relays. Contains engineering drawings, details on types of covers, characteristics, general specifications, and some applications.

(14) J.I.C. PNEUMATIC STANDARDS —Miller Motor Co. Bulletin, 12 pp. Specifications for the application of pneumatics to industrial equipment as listed at the Joint Industry Conference. Covers symbols, diagrams, controls enclosures, mounting, cylinders, pistons, valves and accessories.

(15) SAFETY AND RELIEF VALVES—Manning, Maxwell & Moore, Inc. Catalog, 30 pp. All types of safety valves, relief valves for all uses are listed. Specifications for house heater safety and relief valves. Safety and relief valves of bronze, iron and steel, cast iron with bronze trim, cast iron, cast steel. Use, size, and all specifications for each.

(16) LUBRICATING DEVICES — Gits Bros. Mfg. Co. Catalog 60-A, 16 pp. Illustrations, descriptions, and specifications for all sizes and shapes of oil hole covers, oil cups, bottle oilers, multiple oilers, oil gages, accessories and grease cups, and shaft seals.

(17) ELECTRIC CONTROLLERS — Minneapolis-Honeywell Regulator Co. Catalog 8000, 16 pp. Describes the operating principle and features of the vane types electric contact control units used with the electr-o-vane thermometers and pressure gages, the potentiometers, and the millivoltmeters.

(18) BALL AND ROLLER BEARINGS —Link-Belt Co. Catalog 2550, 112 pp. Illustrations of the complete line of all the ball and roller bearings made by this company. Contains several full page

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(19) PROPERTIES OF GLASS—Corning Glass Works. Bulletin B-83, 14 pp. Complete data on 28 types of glasses used, including facts on mechanical properties, thermal stresses, heat transmission, electrical properties, corrosion resistance, and viscosity data. Curves are given for each subject.

(20) RESISTORS AND RHEOSTATS—Ohmite Mfg. Co. Catalog 40, 96 pp. Data on stock resistors of the vitreous enameled all porcelain type together with mountings. Specifications on precision, and radio frequency resistors, radio frequency chokes, and audio frequency attenuators. Also covers all types of rheostats and cages. Completely illustrated with drawings, photos and curves.

(21) CONDUIT AND CABLE FITTINGS—The Thomas & Betts Co., Inc. Bulletin 65, 64 pp. Illustrations and specifications of cable and conduit fittings for all types of raceways. Included are bushings, elbows, pipe straps, conduit supports, connectors and couplings for all types of conduit and cable, junction boxes, and others. Bolt and screw sizes tabulated.

(22) SWISS PATTERN FILES—The DoAll Co. Catalog 51-821, 8 pp. Illustrations of dimakers files, machines files, the needle file, and the riffler files. All are completely described as to sizes, shapes and the number of the cut.

(23) ROTAMETERS—Brooks Rotameter Co. Bulletin 110. A line of rotameters, designed to meet most purge meter requirements from the Mite small flow indicator of liquids or gases to the high capacity units. Also covers high pressure meters, and research and test kit models used in industry.

(24) FABRIC PACKINGS—Raybestos-Manhattan, Inc. Bulletin, 4 pp. The line of asbestos fabric packings is described with illustrations of each. Included are service recommendations, sizes available, and packaging specifications for high pressure rubber back, rubber core, and dual edge packings.

(25) CORROSION TREATMENT—Octagon Process, Inc. Booklet, 8 pp. Data on Anchorite 100, a paint anchoring, corrosion resistant phosphate treatment for metals. Describes causes of paint failure, and prevention. Discusses method of application, and 100 possible applications.

(26) UNIVERSAL JOINTS—Blood Bros. Machine Co. Catalog 51, 99 pp. Illustrations of all universal joints made by this company, with applications for each. Contains engineering drawings, cutaway views with all recommended sizes for torque. Forging specifications and a parts list are also given.

(27) ALEMITE FITTINGS — Stewart-Warner Corp. Booklet 22-188, 8 pp. Shows line of lubrication fittings in the standard hydraulic, and the hydraulic surface-check design. Made of monel metal, the fittings come in all sizes and shapes in the N.F. taper thread, the N.P.T. pipe thread, the P.T.F. pipe thread, and the N.F. and the N.E.F. straight thread.

(28) DIRECT WRITING OSCILLOGRAPH—Offner Electronics Inc. Bulletin. Applications, construction details, and specifications of the Dynograph, high speed, direct writing oscillograph. Details on chopper type amplifier which makes unit drift-free. Included are engineering, aircraft, laboratory, and power applications.

(29) EXPANDED METAL MESHES — Penn Metal Co. Inc. Catalog 493 EM, 26 pp. Illustrations and description of the manufacture of expanded metal and its uses. Ideas on how to make a little metal go a long way, how to save steel and other materials and get a saving in weight.

(30) SOUND RATINGS—General Electric Co. Bulletin GEA-5672, 4 pp. Describes how the company's fluorescent lamp ballasts are classified according to the amount of natural hum they emit. Includes table listing numbers of ballasts according to their sound ratings in decibels from group A (very quiet) to group F (quite audible).

(31) AIRLESS BLAST CLEANING — American Wheelabrator and Equipment Corp. Bulletin 794. Covers the cleaning of shells, bombs, tank parts, artillery components, and aircraft engine parts with an airless abrasive blasting. Also used for removing rust, scale, and sand from castings and forgings. Included are various applications of shot peening in ordnance production.

(32) MAGNETIC TRAP—Tri-Clover Machine Co. Bulletin 1151, 2 pp. Describes new all-sanitary full-flow magnetic trap. Meets requirements of chemical, bottling, food, and dairy industries, or where liquids must be protected from tramp iron, or other metal particles. Available in 2, 3, and 4 in. O.D.

(33) RELAYS—Phillips Control Corp. Bulletin, 4 pp. Characteristics of eight types of relays. Lists types of coils and resistance available, with max voltage for continuous duty, and tests made with different coils on the various types of contacts made. Illustrations; list of contact ratings; and contact forms.

(34) SMALL CONTROL UNIT—International Resistance Co. Bulletin A-4, 4 pp. A breakdown of the type Q control unit only 15/16 in. in diameter. Illustrations, engineering drawings, and operation curves. Complete list of specifications for the parts used in construction.

(35) VACUUM TUBE ELECTROMETER—Keithley Instruments. Bulletin, 4 pp. Complete specifications for the improved electrometer, a self contained d-c voltmeter. May be used for measuring charged capacitors, piezo-electrical potentials, and d-c amplifier and fm discriminator potentials.

(36) LOW RESISTANCE TEST SETS—Shallcross Mfg. Co. Bulletin 6-12. Describes a line of low resistance test sets and milliohmmeters. Originally developed for determining quality of airplane and railway electrical welds or bonds. Can be used to measure contact resistance of switches, relays and circuit breakers, heavy conductors, and resistance of commutators.

(37) TENSIOMETER — General Electric Co. Bulletin GEA-5512, 8 pp. With two color illustrations, it describes a device for continuous tension indication of cold-rolled strip in steel, brass, and aluminum mills. Also contains diagrams, and lists possible applications.

(38) INDUCTION MOTORS—Allis-Chalmers Mfg. Co. Bulletin 05B7542A, 4 pp. Completely illustrated, construction features are given for the large end-shield bearing, squirrel-cage induction motors. Motors have welded stator yoke, capsule-type housings, split sleeve bearings, silver-brazed cage, and drip-proof design. Available in ratings and speeds up to 1750 hp at 1,800 rpm.

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Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

another "JOINT SUCCESS" story:

KAYDON and Spicer Needle-Bearing P.T.O. JOINTS power take-off joints*

KAYDON standard size precision needle rollers available in 1/16" to 5/16" diameters, flat or rounded ends. Tolerance: .0002" on diameter

*Product of Spicer Mfg. Division of Dana Corp., Toledo, Ohio

precision needle rollers by KAYDON

most compact, high-capacity anti-friction bearing possible

Small, compact, ruggedly built, with high capacity for both continuous and intermittent service, Spicer Needle Bearing Power Take-off Joints meet all power-take-off needs dependably and economically.

As in many other applications, KAYDON precision needle rollers prove they provide the most compact, high-capacity anti-friction bearing possible . . . at low cost. You get the benefit of economy in addition to highest performance-proved quality, in small or large quantities.

Billions of these needle rollers, in standard 1/16" to 5/16" diameters, are in use in automatic and conventional automotive transmissions, universal joints, clutches, steering gears and precision assemblies in many types of machinery. Used between hardened shafts and hardened bores of housings or gears, they eliminate need for bearing races . . . and therefore require no more space than so-called plain or "solid bearings."

When you design for needle roller use, contact KAYDON of Muskegon.

KAYDON Types of Standard and Special Bearings:
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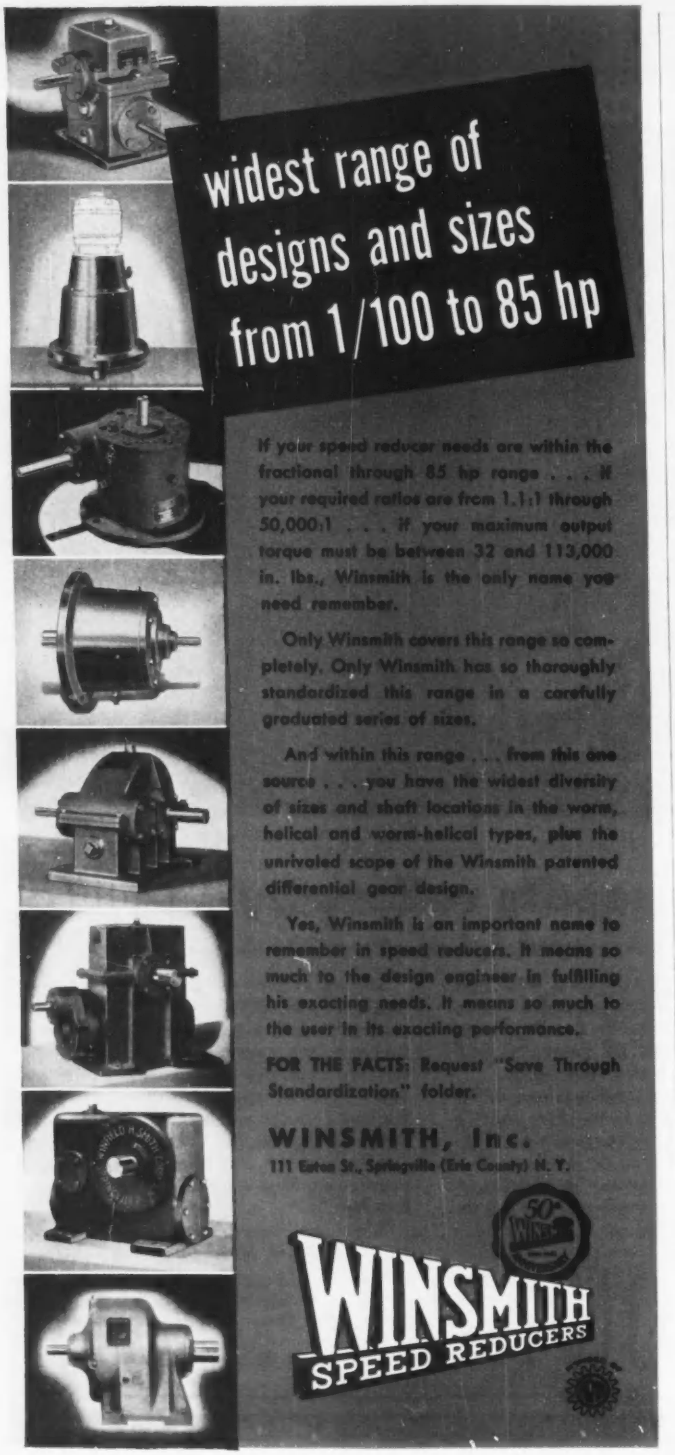
widest range of designs and sizes from 1/100 to 85 hp
If your speed reducer needs are within the fractional through 85 hp range . . . if your required ratios are from 1.1:1 through 50,000:1 . . . if your maximum output torque must be between 32 and 113,000 in. lbs., Winsmith is the only name you need remember.
Only Winsmith covers this range so completely. Only Winsmith has so thoroughly standardized this range in a carefully graduated series of sizes.
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MEETINGS

December 15

WRIGHT BROTHERS LECTURE—U. S. Chamber of Commerce Auditorium, Washington, D. C.

December 26-31

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—Annual Meeting, Philadelphia, Penna.

January 14-17

PLANT MAINTENANCE CONFERENCE & SHOW—Convention Hall, Philadelphia, Penna.

January 14-18

SOCIETY OF AUTOMOTIVE ENGINEERS—Annual Meeting, Headquarters at Book Cadillac Hotel, Detroit, Mich.

January 16-18

SOCIETY OF PLASTICS ENGINEERS, INC.—Eighth Annual National Technical Conference, Edgewater Beach Hotel, Chicago, Ill.

January 28-February 1

INSTITUTE OF AERONAUTICAL SCIENCES—20th Annual Meeting, Astor Hotel, New York.

January 30-31

CASTER & FLOOR TRUCK MANUFACTURERS ASSOCIATION—Wardman Park Hotel, Washington, D. C.

March 3-6

INSTITUTE OF RADIO ENGINEERS—Waldorf-Astoria Hotel and Grand Central Palace, N. Y.

March 11-14

SOCIETY OF THE PLASTICS INDUSTRY—Fifth National Plastics Exposition, Convention Hall, Philadelphia.

March 17-19

FLUID MECHANICS—Second Midwestern Conference, Ohio State University, Columbus, Ohio.

March 17-21

AMERICAN SOCIETY OF TOOL ENGINEERS—1952 Industrial Exposition, International Amphitheater, Chicago.

March 18-19

STEEL FOUNDERS SOCIETY OF AMERICA—Edgewater Beach Hotel, Chicago, Ill.

March 21-April 4

AMERICAN MANAGEMENT ASSOCIATION PACKAGING SHOW—Atlantic City, N. J.

Sans, Souci

Ad Libbing By The Editor

Recently, I received a very important telegram. At least, if length is a measure of importance this telegram from a government bureau or agency was extremely important. Here is the way it read, after deletion of the agency and administrator's name:

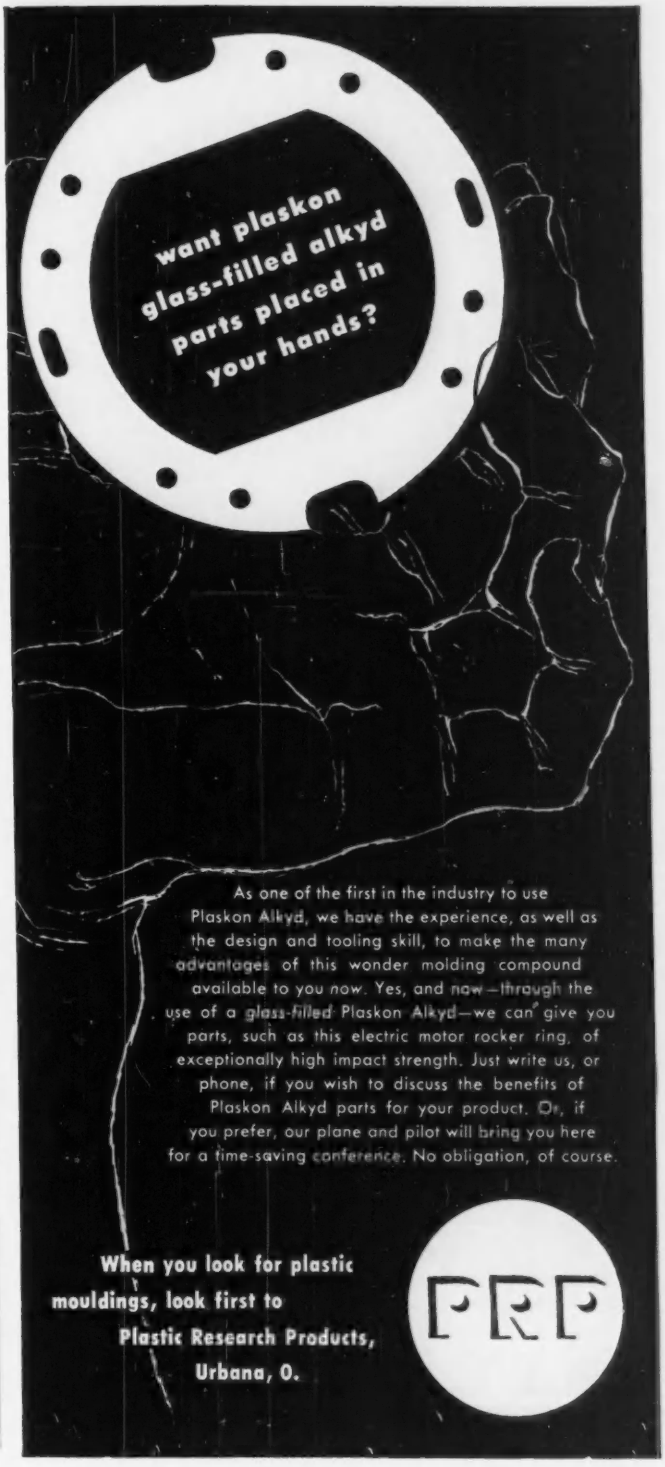
"In view of the importance of the defense production program Mr.—— (the administrator of the bureau) believes that a face-to-face discussion with a group whose views are widely respected by American industry would be of mutual benefit. To that end he would like to have you and other business paper editors who are particularly interested in the field meet in Washington with him and other key officials (of the bureau). Discussions will deal with present and future production and distribution problems. Officials responsible for the administration of the programs will be prepared to answer questions at the meeting most of which will be on the record. Please advise whether your plans will permit attendance Friday, etc., etc. Conference will conclude by noon to enable you to make other appointments"

The telegram was signed by an appropriate individual in the federal employ. It totals more than 150 words. A quick editing would be as follows: "You are invited to a meeting of editors with Mr. —— and other key officials to discuss production and distribution problems on September etc., etc." This second telegram would be slightly more than 42 words, or a little less than one-third the original.

Muckles Make Mickles

To send the telegram that was sent cost, according to Western Union, approximately $2.00. The edited version of the telegram would have been $.90, or only 45 per cent of the cost of the one sent. If the same percentage in economy were exercised in all federal expenditures our tax bill would be reduced about fifty percent. And federal expenditures for this year are expected to be between sixty-five and seventy-five billion dollars.

Of course in view of the fact that the date of the meeting was exactly one week from the date on which the telegram had been sent and a letter would have arrived the next day, there was no real need for the expense of a telegram. The excuse for the waste is,


want plaskon glass-filled alkyd parts placed in your hands?
As one of the first in the industry to use Plaskon Alkyd, we have the experience, as well as the design and tooling skill, to make the many advantages of this wonder molding compound available to you now. Yes, and now—through the use of a glass-filled Plaskon Alkyd—we can give you parts, such as this electric motor rocker ring, of exceptionally high impact strength. Just write us, or phone, if you wish to discuss the benefits of Plaskon Alkyd parts for your product. Or, if you prefer, our plane and pilot will bring you here for a time-saving conference. No obligation, of course.
When you look for plastic mouldings, look first to
Plastic Research Products,
Urbana, O.
PRP

It's TWIN DISC for 'DIESEL-LIFT'!

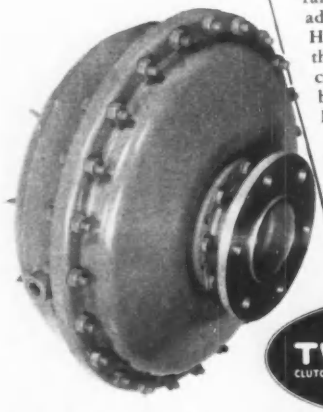
In Twin Disc Hydraulic Couplings, like the one used in Yale & Towne's "Diesel-Lift," the "double circuit" route which the fluid follows serves to balance the thrust load, increase the capacity for any given size.

Yale & Towne selected a *Twin Disc* Hydraulic Coupling to put the power to work on its *new "Diesel-Lift"* fork truck. And here's why:

This "double circuit" *fluid drive* eliminates chattering, stalling and lugging . . . eliminates, too, damaging starts and stops—and assures the *availability of full engine power* for heavy pulling and steep ramp work.

***Cushioned* power that *hangs* on . . . velvet glove power that permits the engine to work in its most efficient range *all the time* . . . these are the advantages you get with Twin Disc Hydraulic Couplings. And because these couplings are of "double circuit" design, thrust loads are fully balanced, and the coupling occupies less diameter per hp.**

Chances are you, too, like Yale & Towne, will turn to Twin Disc Hydraulic Couplings for *new* performance characteristics from your equipment when you learn the complete story. Write today for Bulletin No. 144-C on fluid drives. No obligation.



TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

"What does a few cents amount to?" It is not a question of cents, it is a matter of sense and principles. This instance simply reflects the extravagance and waste in government operations whether it be sending a telegram or building an arsenal.

Judge Not By Appearance

The extreme opposite of the wasteful attitude permeating government operations is demonstrated by the business operations of a man who was a tremendous financial success. I knew him over a period of more than twenty years. He was known as "Big Frank". Many people admired him, some feared him, and some did both. He was six feet plus, weighed almost exactly an eighth of a ton. When in deep thought or an argument, his face was stern; when he spoke excitedly, anyone almost totally deaf could hear him five feet away or further.

Because Big Frank was such a rugged individual, easy mixer and spoke with such a strong Italian accent, many people failed to recognize his keen mind and shrewdness. And because of his size, his expensive hand tailored suits did not bespeak their cost, so he never looked the millions which he was worth. Many people underrated him upon first acquaintance.

There came a time when Big Frank wanted an experimental machine built. It was his invention. No one knew whether it would work or not. Most people were sure it wouldn't, but not Big Frank. He went right ahead and got a bid of $25,000 from one company to build the machine and he accepted the bid.

Signing the Contract

When it came to signing a contract in the office of the V. P. in charge of sales of the company, the veep got a little nervous and wanted to be sure that Big Frank would be able to meet the bill even if the machine didn't work. So he said:

"Mister, no one knows whether this machine will work or not. Now suppose we build it and you try it and it fails. Are you prepared to send it to the scrap pile and kiss your $25,000 good-by?"

Big Frank looked at the veep and glowered. He had the veep's business card in his hand and began tapping it edgewise on the table but said nothing. Knowing that Big Frank was worth considerably more than a million dollars and was proud of his financial ability to pay, and knowing Big Frank's methods, I waited with great expectancy to hear what was coming. The tapping continued, Big

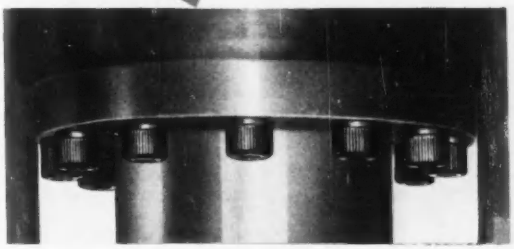
UNBRAKO® CAP SCREWS

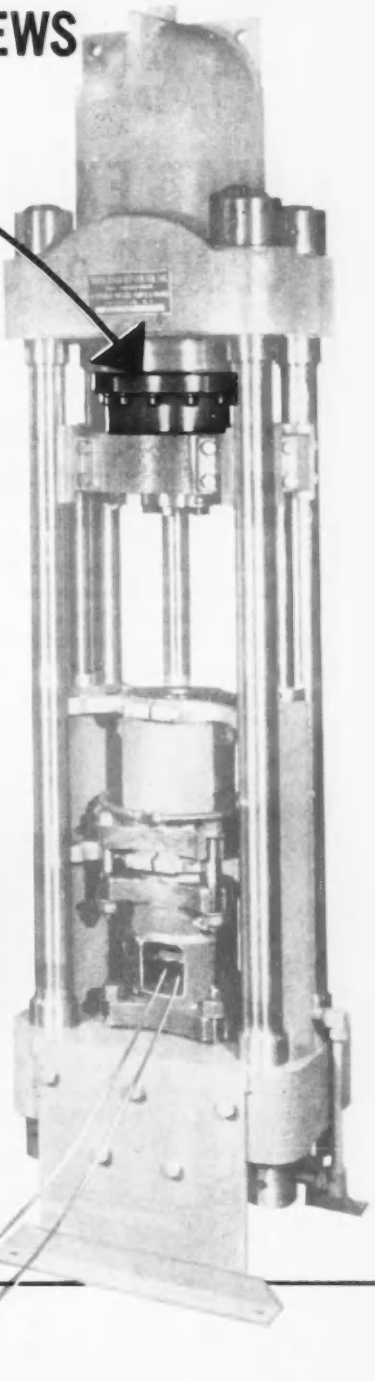
ARE STANDARD ON THIS 170-TON EXTRUSION PRESS

Because ease of assembly, strength and neatness were important factors in the production of this special oil-operated lead extrusion press, "Robertson" specified UNBRAKO Knurled Head Cap Screws.

Why not investigate UNBRAKO for your product? We'll be glad to send descriptive literature and samples promptly. Write on your business letterhead today.

This Robertson Press operates at the unusually high hydraulic pressure of 6000 p.s.i. Normal pressure found in a press of this kind is 2500 p.s.i.





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STANDARD PRESSED STEEL CO.
JENKINTOWN 30, PENNSYLVANIA

UNBRAKO®
SOCKET SCREWS

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HEAT EXCHANGER COOLER or CHILLER

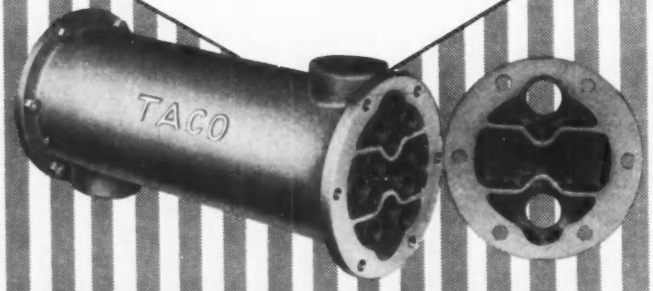
WHAT SHAPE? WHAT TYPE? WHAT MATERIAL?

for heating or cooling...

WATER • HYDRAULIC OILS • LUBRICATING OILS
COOLANTS • CUTTING OILS • OTHER LIQUIDS

Our engineering department will gladly assist you, just as it has numerous other organizations, in design and selection of proper exchanger for your particular requirements.

A heat exchanger specialist from the factory is immediately available. Just call Providence, R. I., GAspee 1-2600, wire or write.



Illustrated is just one of more than 100 different shapes we are making as component parts for manufacturers.

TACO HEATERS INCORPORATED
137 South St., Providence 3, R. I.

Frank just sitting there tapping and glowering. Finally after a silence that was getting embarrassing, he spoke.

"Mr. Weiss, I have a bank in Ithaca, one in Hoboken, and one in West Palm Beach, Florida and two banks in New York. On which one of these banks do you want me to draw a check for $25,000?"

The veep saw the point and got a little red and then tried to explain that he just wanted to be sure that no embarrassing situations would develop. And after all, he explained, Big Frank was a comparative stranger to him and he thought it would be best for everyone to speak plainly. And so on and so on went the explanation with Big Frank listening and getting madder by the minute. Finally he replied:

"Mr. Weiss, it says here on your business card that you are the vice president in charge of sales. I know you do many tens of millions of dollars of business during a year. So I guess you consider yourself a business man. Don't you?"

The veep's face got somewhat more red and he hesitantly allowed that he considered himself a businessman, to which Big Frank replied:

"Mister, I am not a vice president and I do not have a one hundred million dollar business. But I think that I too am a business man. And when I have to do business with a man and don't know how much money he has I go to a book. Maybe you have heard of it. It is called Dun & Bradstreet. I don't insult the man to his face."

Naturally, the veep became extremely embarrassed. He had made a bad mistake in judging Big Frank's wealth from his appearance. On the other hand, Big Frank revealed his shrewdness when he withheld his answer until he had figured out not only his answer but also the reply he might expect to get and what he would then say to close the matter.

Only too often we make hasty judgments on the basis of appearance. This holds true not only for human relations but even in our problems relating to technical matters. But we should always remember when we first meet people that they have far more than appears on the surface. And finally, there is a vast difference between education and intelligence. Many of the men whom I have met were short of formal education but extremely long on intelligence.

Design Changes

One of the things that is contributing most to the building of the design profession is the fact that today it requires a lot more knowledge than

New Tool Microhones

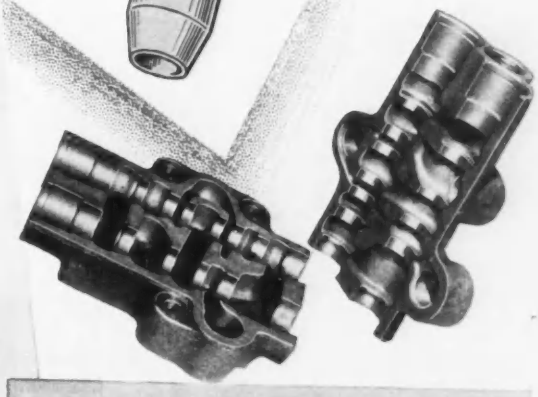
INTERRUPTED BORES

to precise tolerances

Plastic guides stabilize tool as abrasives cross keyways, undercuts, ports, reliefs, or cross holes.

The guides are forced out radially against the surface by the same cone (wedge) that applies pressure to the abrasives. The plastic wears down with the abrasive and keeps the abrasive generating a true cylinder without injurious over-cutting or breaking the edges of the interruptions in the surfaces.

Lands in cast iron hydraulic control panel held to .0002" for size, roundness, straightness and alignment. No lapping or selective fitting of spools is necessary. Holds 750 lbs. pressure without leakage or binding.



Write for issue of Cross Hatch describing MICROHONING of Interrupted Surfaces.

MICROMATIC HONE CORPORATION

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District Field Offices: 1323 S. Santa Fe Avenue, Los Angeles 21, California • 206 S. Main Street, Rockford, Illinois • 231 S. Pendleton Avenue, Pendleton, Indiana • MICRO-MOLD Manufacturing Division, Boston Post Road, Guilford, Connecticut • 55 George Street, Brantford, Ontario, Canada

The Swing is to
Durakool
a dependable
10 YEAR SWITCH
Steel-clad with mercury to mercury contacts, the Durakool hydrogen filled switch is performing with sensational dependability.
★ Millions of contacts without a falter
★ Positive "Make and Break" contact action
★ Withstands high temperatures
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★ Seven new models—1 to 65 amperes
★ Smaller in size, increased capacity
Send for BULLETIN 525
Steel Durakool
MERCURY SWITCHES
See Telephone Directory for Local Distributor or write
Durakool, Inc.
Elkhart, Indiana

was required only three decades ago. There are two reasons and they lock together. Today the fund of engineering knowledge is vastly greater than it was thirty or forty years ago. Secondly, this new knowledge is being used to develop the designs of machines which would have been impossible to design thirty years ago.

Unfortunately, the superior design technology that is put into the product is not revealed by the appearance of the machine. The design proportions used to avoid vibrations in the natural frequency range are not evidenced by merely looking at the machine. Appearances do not always reveal the quality of the engineering that went into its design.

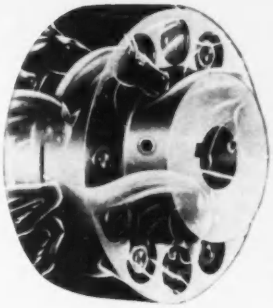
Fatigue Failures

Some years ago the engines on an air ship failed one after the other. The crankshafts broke. Naturally an investigation was made. A check on the design of the crankshaft showed that it was exactly the same as the crankshaft on a number of other engines of the same design. These crankshafts were taken out and inspected very closely but there was no sign of failure. It was not until the original designer of the engine installation was interviewed that the cause of the failure was determined.

According to the reports, there was a clutch between the engine and the propeller. One of the clutches started slipping so the repair crew decided that the clutches needed stiffer springs. Unfortunately, the heavier springs put the natural frequency of the assembly close to the operating rpm of the engine. Of course extreme vibrations resulted. They caused the fatigue failure of the crankshaft of all of the engines in which the clutch springs had been changed. The motto is that it is dangerous for a maintenance crew to modify the smallest detail in the modern highly engineered machine and experience shows that the design of the many elements and members is so highly critical that a novice or amateur is almost bound to make a mess of it.

Soon all industry will begin to understand that manufacturing requires the highest grade of talent in engineering design. Many companies already recognize it. Those that expect to stay in business will have to understand it. The present shortage of engineers is compelling many companies to give far more serious thought to the personnel in their engineering department. It takes a lot of studying, experience and common sense to be a good engineer. And it is requiring more of it every year.

—G. F. N.



ALL THE HORSEPOWER GOES THROUGH THE COUPLING

Coupling Design of Far Reaching Importance To Plant Economy

Today's demand for high production and continuous operation emphasizes the importance of using correctly designed flexible couplings to offset unavoidable shaft misalignment on direct-connected machines. With clearances measured in thousandths, protection against expensive damage to precision machines reduces shutdowns and expensive replacements.

Ajax rubber-bushed Flexible Couplings have been recognized as standard for 30 years.

They provide positive resilient drive. Ajax Couplings are available with rubber or Neoprene bushings to suit conditions. They are made in a wide range of sizes in standard, bolt-on, brake drum and other types, with flanges made of ferrous and nonferrous metals. Write for Bulletin 48.

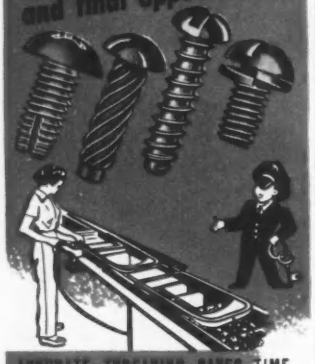
AJAX KNOWS COUPLINGS

Working Hand-in-Hand With America's Leading Manufacturers and Users of Direct-Connected Machines for Thirty Years...

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, NEW YORK

PRECISION MADE
Pheoll
SCREWS, BOLTS, NUTS and SPECIAL FASTENERS
save assembly time
improve product strength
and final appearance



ACCURATE THREADING SAVES TIME

Pheoll Screws, Bolts, and Nuts are easier to start, easier to drive and easier to tighten—because they're accurately machined and threaded. These features cut your assembly time and cost.

COLD ROLLED THREADING ADDS STRENGTH

The grain structure and flow of metal obtained through cold heading and roll threading increases the structural strength of Pheoll Fasteners. Cold working improves thread bearing surfaces, providing greater area of contact for firmer grip. Greater strength reduces possibility of shearing, and time lost in subsequent removal and retapping.

OUR INSPECTION IMPROVES YOUR PRODUCT APPEARANCE

Step by step Pheoll inspection, through every process of production, assures uniform head size and shape; cleanly milled and recessed heads, neat chamfering and countersinking. All these factors contribute to the quality and finish which add materially to your product's final appearance. *Write* for Pheoll's product literature and price list.

THESE PHEOLL PRODUCTS INCREASE YOUR PRODUCTION RATE. Thumb Screws Machine Screws† • Wood Screws† • Sheet Metal Screws† • Stove Bolts† • Rolled Threaded Wires and Studs • Special Rivets and Pins • Brass Washers

†Furnished in slotted and Phillips Recessed Head Types

Pheoll
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5700 ROOSEVELT ROAD
CHICAGO 50, ILLINOIS
SCREWS • BOLTS • NUTS

ENGINEERING ABSTRACTS

Gas Turbine Alloys

Abstracted from "The Nimonic Series of Alloys . . . Their Application to Gas Turbine Design", Publication No. 440A, The Mond Nickel Company, London.

FOLLOWING THE DISCOVERY OF the nickel-chromium alloys in 1908, materials have been developed capable of extended life under intermittent heating and cooling, and of continuous service at high temperatures. These alloys, marketed under a variety of trade-names but based essentially on the 80/20 nickel-chromium solid solution, are largely used for electrical heating purposes. Besides the high electrical resistivity required for this purpose, these alloys are noteworthy for their resistance to oxidation in high temperature service and for the adherence, toughness and protective character of the oxide scale formed.

It is from materials of this type that the Nimonic series of alloys has been developed. These alloys, while retaining the well-known oxidation and corrosion resistance of the 80/20 nickel-chromium base alloy, are intended for use where only a limited amount of creep deformation can be tolerated under high stresses at elevated temperature.

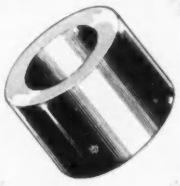
This series of alloys, all of which are in regular service, has been closely linked with the development of the aircraft gas turbine, both for jet and air-screw propulsion.

Properties of Materials in Relation to Gas Turbine Design

Service in gas turbines provides the most advanced examples of high temperature operation at high stresses. Conditions are severe and sometimes impossible to anticipate, for in the principal components the calculated conditions of stress and temperature are combined with variable temperature gradients and vibrational stresses which can be estimated only roughly. Furthermore, adequate oxidation resistance of alloys is essential, for loss of metal thickness due to inadequate heat-resistance leads to loss of load-carrying capacity. These properties are difficult to assess in any but a qualitative manner in the laboratory; the suitability of any given material has to be proved finally under the special conditions of a given service.

Creep-Resistance—The main effect of

WORKS WHERE OTHERS WON'T



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GRAPHITE METALLIZING CORPORATION
1012 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

stress at the high operating temperatures is the continuous deformation that takes place in the course of time. This phenomenon, commonly referred to as 'creep', takes place at stresses below the limit of proportionality as determined in a short-time tensile test. Stresses giving rise to such continuous deformation will eventually lead to failure of the part by change of dimensions, if not by fracture.

A typical creep curve shows that the course of deformation with time is divided into three parts, namely the primary stage in which the creep rate decreases rapidly; the secondary stage, which covers the major portion of the life of the component and in which the creep rate is decreasing slowly or is substantially constant; and the third stage in which the rate of strain is rapidly increasing, leading eventually to fracture. Existing knowledge of the condition of a material during this third stage of creep prior to fracture is limited and it is considered wise to restrict the life to the determinable period of the secondary stage.

The prime factor of 'strength' can be described more fully in respect to particular components. For example, the material of the rotor blades of a gas turbine is subject to centrifugal stress due to the rotation at high angular velocity, and to a bending stress due to the reaction of the impinging gas. Under the effect of these stresses the material elongates with time and it is necessary, knowing the range of service temperatures and the magnitude of the stresses, to estimate the overall elongation of the blade, so that the initial bladetip clearance can be designed to avoid 'rubbing' on the casing. Since the efficiency of the turbine is increased by reducing this clearance the capacity of the material to resist 'creep' under stress at temperature is of major importance.

For the design of blades in aircraft turbines the creep deformation in periods up to 300 hours is of interest in selecting operating conditions. Since in the life of an aircraft turbine the most severe conditions of stress and temperature occur during take-off and climb in a relatively short portion of the total life, and since the majority of the life is under less arduous cruising conditions, the properties of the material must be considered at both upper and lower levels of stress and temperature. In doing this, factors of safety in time, stress and temperature are used. The blade temperature is by no means uniform and is at maximum near the tip; the centrifugal stress is highest at the root. For turbines of longer life the conditions may not be the same as for aircraft.

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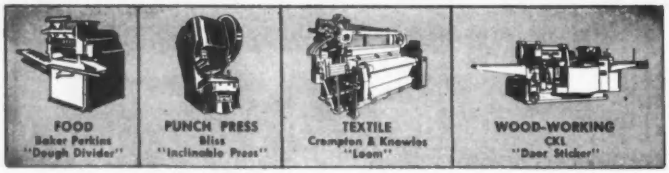
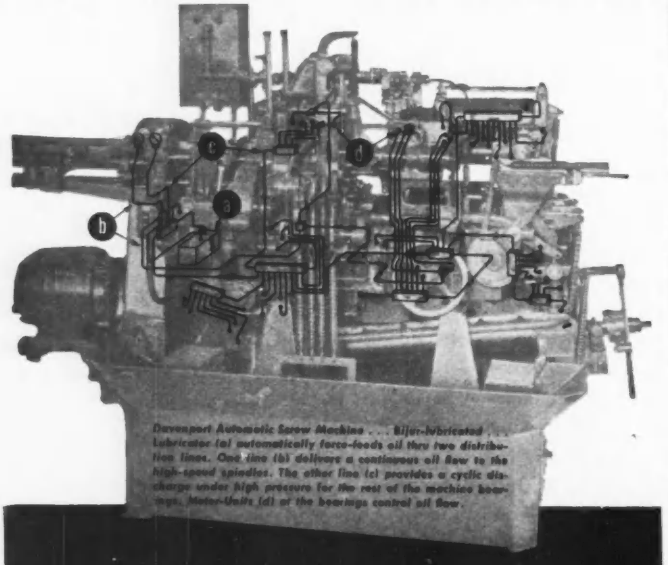
LEADING MANUFACTURERS BUILD IN THE BIJUR SYSTEM



automatic lubrication


Davenport Automatic Screw Machine . . . Bijur-lubricated . . .
Lubricator (a) automatically force-feeds oil thru two distribution lines. One line (b) delivers a continuous oil flow to the high-speed spindles. The other line (c) provides a cyclic discharge under high pressure for the rest of the machine bearings. Meter-Units (d) at the bearings control oil flow.

boosts production and cuts maintenance

Designing an automatic lubricating system into a machine doubles your prospects for user satisfaction.

First, maintenance time is converted into more time for production. A Bijur-lubricated machine oils itself during operation, doing away with wasteful down-time for lubrication.

Next, maintenance costs are cut as effective bearing life is lengthened. The Bijur system provides positive Meter-Unit control of oil flow *at the bearings*, considerably reducing bearing wear.

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The correct oil film to each individual bearing...

389

BIJUR
LUBRICATING CORPORATION
ROCHELLE PARK, NEW JERSEY

The course of the stress and strain parameters with temperature must be studied in conjunction with the operating conditions. This type of information enables designers of installations intended for a total life of 100,000 hours to design renewable components on a basis of 10,000-15,000 hours' service life. Designers of equipment intended to operate for very long periods may desire to extrapolate the various curves of creep properties, but in view of the fact that the mathematical basis of creep curves has not yet been established they should note that there is no justification for assuming that any plots of this type should be straight lines. Great caution must, therefore, be exercised when extrapolating such results to longer times. The stress/log. time plot is to be preferred in view of the more conservative indications on such extrapolations.

Fatigue-Resistance—In addition to the steady stresses imposed on gas turbine rotor blades, there is a fluctuating gas bending stress and an unknown degree of fluctuating stress arising from various sources. Neither the magnitude of the latter nor its duration during the turbine life is known, though designers can lessen the likelihood of its occurrence. In assessing materials for their behaviour under such complex conditions, laboratory fatigue tests may me of little practical importance, due particularly to the much lower frequencies at which they are made. They do, however, give some indication of the relative merit of different materials. Such tests should give an indication of the combined effect of creeping and fatigue on a particular material.

Thermal Expansion—In choosing an alloy for use in conjunction with other materials, metallic or non-metallic, and in minimizing the effect of temperature gradients consideration must always be given to the thermal expansion. For example, the cooling effect of the stator ring leads to a high temperature gradient on starting, consequently the frequent starting and stopping, to which aircraft gas turbines are subject may lead to cracking or buckling of the guide vanes.

Corrosion-Resistance—Corrosion by the products of combustion may itself govern the life of a component and accelerate creep or fatigue failure. Although Nickel-base alloys are susceptible to attack by sulphur-containing compounds, the degree of attack is not high under strongly oxidizing conditions such as exist in most regions of a gas turbine. A high resistance to oxidation under conditions of repeated heating and cooling is of major impor-

tance. The 80/20 nickel-chromium alloys form a strong closely adherent oxide which protects them from progressive attack. With all high-temperature materials, however, there is the possibility of attack by other constituents of the ash of certain fuels, in particular vanadium pentoxide, the effect of which is accentuated by the presence of sulphur and alkali metals. The nickel-base alloys have, both in laboratory investigations and in service, shown themselves to be more resistant to corrosion than are the iron-base materials.

Ease of Fabrication—In addition to having the physical and mechanical properties described, the materials should readily lend themselves to fabrication. Parts, such as combustion chambers, manufactured from sheet must be made either by rolling or deep drawing and may then be welded. While stator blade segments can be formed from rolled secion or precision cast, the materials for rotor blades of aerodynamic form are preferably made from forged material. This is not due to any inability to produce the desired dimensions by casting, but to the fact that castings exhibit less uniform properties than wrought components and the service behavior of the engine is, of course, dependent on that of the weakest component.

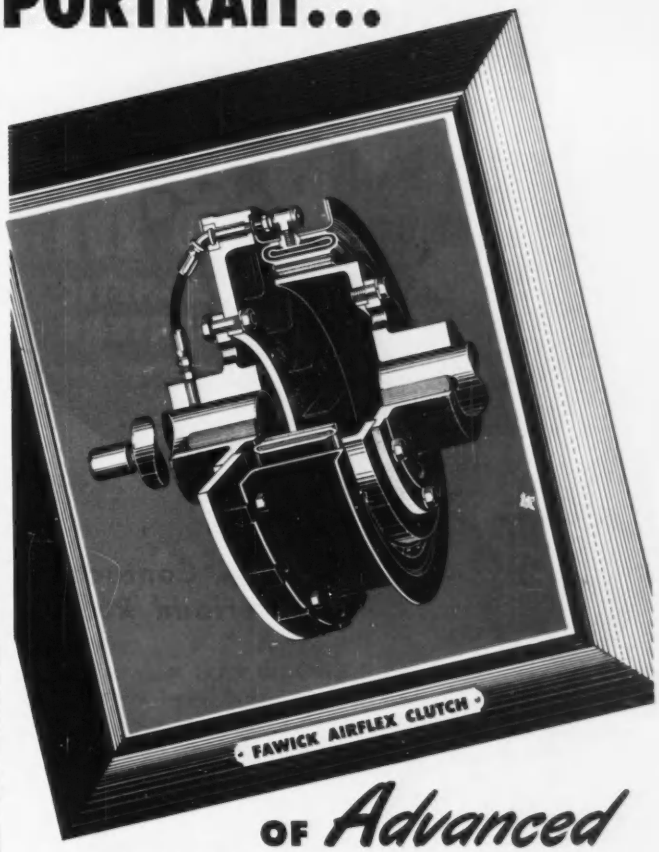
The properties of the Nimonic series of alloys are presented in this booklet in relation to the above stated requirements for the more important high temperature gas turbine components as they appear to the design and materials engineer.

The following table lists the composition of the alloys. Creep and fatigue data and heat treating practices are included in the booklet.

Type of Alloy	Name
80Ni, 20 Cr, Ti, Al	Nimonic 80 Nimonic C Nimonic CC
80 Ni, 20 Cr, Ti, Al	Nimonic 80A
62 Ni, 20 Cr, 18 Co, Ti Al	Nimonic 90 Nimonic B Nimonic CB
80 Ni, 20 Cr, Ti, Al	Nimonic 75
72 Ni, 20 Cr, 8 Fe, Ti, C	Nimonic F Nimonic CF
37 Ni, 18 Cr, 2 Si, bal. Fe	Nimonic D

Note: Numbered series are creep tested wrought alloys.
One letter series are wrought alloys.
Two letter series are casting alloys.

PORTRAIT...



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Advances in engineering and in operating efficiency are typical of Fawick Airflex design developments to provide industry with better, simpler pneumatic power transmission.

Written into the operating stories of these superior clutch and brake units you will find many advantages that will improve the production efficiency of your machines. For instance, the ventilating adapter in the Fawick CB Clutch shown above creates forced-air circulation through the entire unit for cooler clutch operation under all working conditions.

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FAWICK AIRFLEX COMPANY, INC.
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For further information on Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin ML-22.

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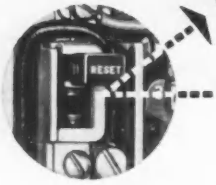
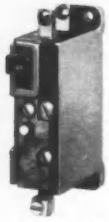


--- With Visible Contact Overload Relays



Heater element cannot be assembled to the starter incorrectly.

Bi-metallic thermal overload relay assembly replaceable without removing starter from enclosure. Designed for separate mounting without sub-panel assembly.

TRIP-FREE Manual reset is standard. Manual-Automatic Reset available on special order at no extra charge.

R-B-M Size 0 and 1 A.C. Magnetic Starters have identical overall panel mounting dimensions. All parts, except stationary and movable contact assemblies, are common to both sizes.

Ilsco solderless lugs, suitable for #6 maximum wire size, are standard. Screw terminals are available on special order. Magnet coil can be removed without disassembling the starter. Stationary and movable contacts replaceable without disconnecting wiring. Enclosed heater element, expanding U-shaped bi-metal and snap action contact mechanism provide dependable, accurate motor overload protection.

Small overall size, plus indentical mounting dimensions for 10 and 15 ampere 2 to 5 pole contactors, as well as Size 0 and 1 non-reversing starters, make the R-B-M line extremely flexible for control panel layout.

Two 5 pole contactors mechanically interlocked with overload protection on common base. Unwired. Note interchangeability of 25 ampere N.O. contacts and 15 ampere convertible N.O. or N.C. interlocks.

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OUR READERS SAY

(Continued from Page 157)

To the Editor:

I have read with interest your editorial "A Job for Engineering Societies."

I think it is perfectly true that any organization must occasionally audit its records to make sure that it has not become engrossed in self perpetuation to the elimination of more useful functions. It is not for an organization simply to vegetate and develop satisfactorily as to the number of its members, without also performing a useful function and service to the nation of which we are all a part.

This is a project to which not only engineering societies, but every organization of American citizens should devote its first attention at this time. I don't think it makes any difference what the charter of the organization is—this is a matter of common citizenship and it is just as much the responsibility of an engineering society as it is of a parent-teachers association.

Above all, as an individual citizen, the engineer should be a focal point in his community, of a persistent drive to insure integrity in public office and in the conduct of public affairs.

You ask whether Government administrators would welcome such activities by engineering societies? You may be dead sure that many will not. They will bitterly resent it. They will say the engineering societies have entered into the field of politics where they do not belong. If you are going to avoid doing anything that will lead to criticism from Government administrators, this nation is in desperate trouble.

—TELL BERNA
General Manager
National Machine Tool Builders' Assoc.

Ed—Politics is everybody's job, as Mr. Berna indicates.

Let the Members Speak Up

To the Editor:

Your editorial is certainly a worthy suggestion. Some of the professional societies may hesitate to follow it because of the fear of getting into a political argument which most of them endeavor strenuously to avoid. My suggestion is that you approach The Presidents and Executive Secretaries,

SEVERAL OPERATIONS SAVED
by rolling this shape
Maybe the section you want to sub-contract doesn't look like this one but . . . the same economies will apply. The section illustrated demonstrates our lower cost story. Punching, notching, roll forming and cutting to length of this specific piece are done in one continuous operation. As a designer or production man, you know how the saving of operations lowers the unit cost. Continuous rolling saves man hours, eliminates extra handling of parts, and improves uniformity and accuracy.
How about your part?
We have the equipment in our modern plant to turn out your parts by the thousands or millions on a good delivery schedule. Why not try Roll Formed Products on your next requirement? Send us prints or parts for prompt quotation. If you would like to know more about us, write for our brochure with the whole story.
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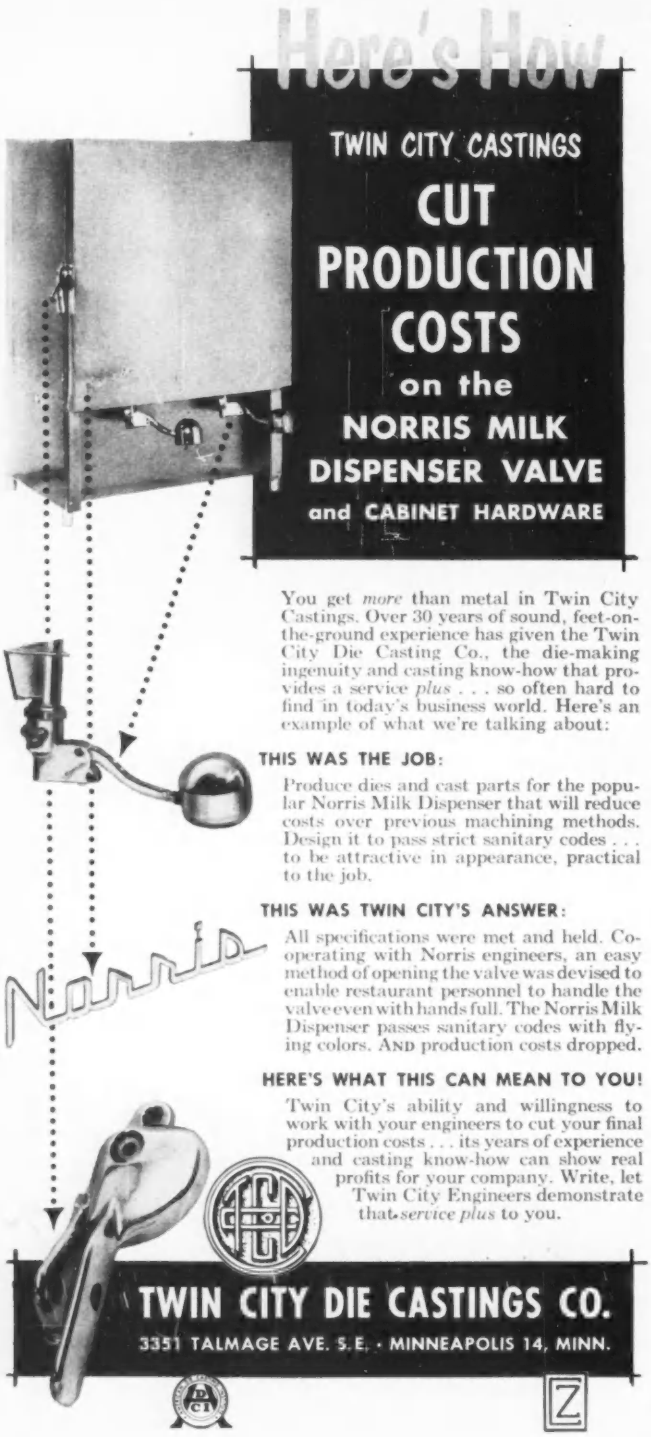
Here's How
TWIN CITY CASTINGS
CUT PRODUCTION COSTS
on the
NORRIS MILK DISPENSER VALVE
and CABINET HARDWARE
You get *more* than metal in Twin City Castings. Over 30 years of sound, feet-on-the-ground experience has given the Twin City Die Casting Co., the die-making ingenuity and casting know-how that provides a service *plus* . . . so often hard to find in today's business world. Here's an example of what we're talking about:
THIS WAS THE JOB:
Produce dies and cast parts for the popular Norris Milk Dispenser that will reduce costs over previous machining methods. Design it to pass strict sanitary codes . . . to be attractive in appearance, practical to the job.
THIS WAS TWIN CITY'S ANSWER:
All specifications were met and held. Co-operating with Norris engineers, an easy method of opening the valve was devised to enable restaurant personnel to handle the valve even with hands full. The Norris Milk Dispenser passes sanitary codes with flying colors. AND production costs dropped.
HERE'S WHAT THIS CAN MEAN TO YOU!
Twin City's ability and willingness to work with your engineers to cut your final production costs . . . its years of experience and casting know-how can show real profits for your company. Write, let Twin City Engineers demonstrate that *service plus* to you.
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men like Calvin Brown and C. A. Davis of the ASME.

—FREDERICK S. BLACKALL, JR.
President & Treasurer
The Taft-Peirce Mfg. Company

Ed—It is regrettable that Mr. Blackall is right. In some societies, you just don't talk about politics.

A leading Educator Speaks Out

To the Editor:

The gathering wave of indignation at practices by certain government personnel which might be termed "legal corruption" should be the concern of engineering societies as it should be the concern of every respectable organization of citizens.

Engineers, as leading members of their communities, can do a little to improve the situation; banded together in engineering societies, they can do more; but by joining, as individuals and as society members, with the other professional men and women in the community—doctors, lawyers, teachers, journalists—to arouse all right-thinking and right-acting persons to the national dangers inherent in the situation, they can do far more.

Just seventy-five years ago, The Cooper Union was the scene of a mass meeting of indignant citizens who formed plans to rid New York City of the notorious Tweed Ring. There may be a hint in the success of that action for societies and institutions allied with the engineering profession.

EDWIN S. BURDELL
President
The Cooper Union for the Advancement of Science and Art

Ed—It is a splendid hint, Dr. Burdell, and we hope to see it taken.

Too Deep for the Miners?

To the Editor:

I think you have expressed a feeling that many of us have—that somehow, good citizens ought to make their influence more directly felt on our government.

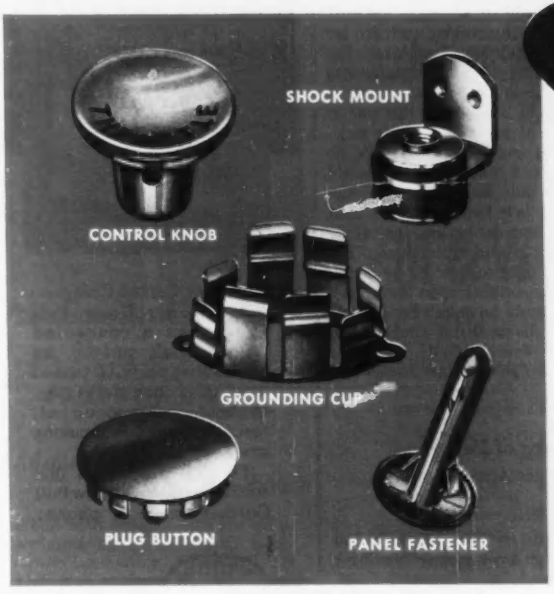
However, the effectiveness of the approach which you suggest—namely, the direct action of technical societies—is seriously questioned by many people; and there is no doubt about the serious complications that are involved to any technical society that steps outside the field of technical activity. So far, these difficulties have seemed to our Institute to be too serious to warrant our becoming involved.

Your editorial will, I am sure, interest a great many people who have opinions on this important though con-

This is a Wrinkle Remover?

Not for you, Mrs. Uppington. This little TRIMOUNT fastener smooths *technical* wrinkles . . . the kind that crease a product engineer's brow when he's puzzling over an assembly problem, trying to cut labor costs and still get lasting, trouble-free fastener performance.

In many applications, TRIMOUNT spring-action fasteners eliminate the need for screws, washers and nuts. They *snap* in and hold *tight*, assure vibration-proof attachment for panels, mats and sheet metal assemblies. They are made in a wide range of types and sizes for the automobile, aviation, appliance and radio and television industries.



Like the versatile TRIMOUNT, thousands of other United-Carr fasteners and allied devices are helping manufacturers all over the United States to speed production, turn out better products. A few are illustrated to demonstrate the versatility of United-Carr's design engineering staff. Each *tailor-made* to solve a particular problem for a particular manufacturer, they prove conclusively that precision need not be sacrificed, even in *volume* production.

Making use of United-Carr's varied experience in this specialized field has saved many manufacturers a great deal of time and trial-and-error experimentation in their own engineering departments. That's why, more and more, the leaders in industry are bringing their fastener problems to United-Carr—FIRST IN FASTENERS.

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- Fuses into a non-laminar homogeneous mass.
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A FEW OF THE MANY BI-SEAL APPLICATIONS:

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troversial subject.—W. M. PEIRCE
President
American Institute of Mining & Metallurgical Engineers

Ed—Of course it may be controversial. That is what makes horse races, and in every race there is a winner. After all the country's biggest "technical" society, The American Medical Association has done a tremendous political job in saving this country from socialized medicine.

To the Editor:

I have read your editorial entitled "A Job for Engineering Societies", reread it and have circulated it among some of our men in this office. Certainly, we have mixed reactions. I guess engineers have always been notorious for their lack of broad interests, culture and managerial ability. I think the engineering profession has been done a great injustice in having that kind of a tag tied to them, but I will have to admit that the average person of an engineering mind is inclined to follow the narrow engineering path rather than broaden his education and field of activity.

Of course, engineering societies are not entirely made up of engineers, but I have a feeling that such organizations could not be as effective in the work that should be done along this line as other types of societies. I don't mean by this that engineers should not do all they can. I think everyone should do all they can. Engineering societies can certainly help kindle the fire within their own boundaries and that alone would be of considerable value. The pressure brought to bear by the members of these societies upon their legislators, etc. could be quite effective, but something tells me that it would not be a powerful factor. —G. H. SANBORN
The Fellows Gear Shaper Co.

Bound Copy of Design Work Sheets Appreciated

To the Editor:

Thank you very much for the bound copy of design work sheets which have been reprinted from PRODUCT ENGINEERING.

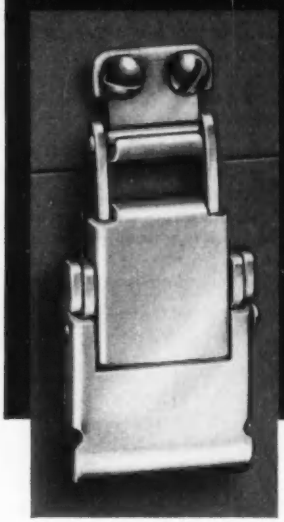
This is the best idea I have seen in a long, long time. I am certainly glad to hear that you will be doing this regularly now for all subscribers, since we do have considerable trouble with men wanting to cut up copies of the magazine in order to maintain their own files.

Your decision to furnish these to

New Spring Loaded Catch

with concealed spring

Meets U. S. Signal Corps Specifications



This new Corbin Compression Spring Draw Pull Catch has a concealed spring, flush surface, no protruding parts. 60 pound load at ⅛ inch deflection. Withstands 600 pound pull test. Overall dimensions are 2¾ x 1⅛ x ⅜.

For full details on this and other Corbin Draw Pull Catches, write or phone:

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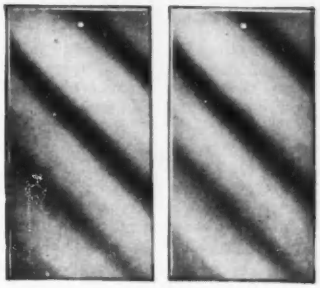
(Advertisement)

Clear Coatings for Zinc and Steel Stand 800 hours' Salt Spray

Increased use of zinc die castings and of zinc-plated steel to replace unavailable materials, combined with the tight supply of copper, nickel and chromium normally used for plating zinc, has focused attention on surface coatings comparable to plating in service performance. Unbiased laboratory tests show that at least two of the clear finishes in the company's line withstand the exceptionally long period of 800 hours' exposure to salt spray and to weatherometer tests.

Effectively protect zinc

These tests demonstrate that DULAC Clear Universal Lacquer #462 and CODUR Clear Synthetic Y743 provide completely satisfactory protection on zinc, zinc plated steel and steel. Even after the unusually severe tests to which these finishes were subjected, there was no indication whatever either of failure of the coating or of discoloration of the zinc.



(Left) A zinc-plated steel panel newly coated with DULAC #462. (Right) A similar panel after 800 hours' exposure to salt spray, showing no evidence of attack on the finish.

Adaptability to Drying Schedules

While both finishes give the same performance, DULAC #462 is an air-drying coating, while CODUR Y743 is a baking type. This permits choice of the correct finish to fit into the drying schedules of a particular finishing room.

Technical Data Bulletin #110 on clear finishes is available from Maas & Waldstein Co., 430 Riverside Avenue, Newark, 4, N. J. On request, M & W Technical Service Engineers will discuss specific problems.

NOW! simulate copper, brass and bronze on products like these with

M&W PLATELUSTRE

Don't let critical metals put a *needless* crimp in your production!

Take zinc or steel—apply a coating of one of the new PLATELUSTRE finishes. You wind up with products and parts that look so much like copper, brass and bronze that *the eye can scarcely tell the difference!*

Whether you have been using now unavailable copper and its alloys for *making* products or for *plating* products, you will find these new M & W finishes *equally* effective in keeping your plant running. There are types for air-drying and baking schedules — pick the one that best fits *your* production requirements.

Let an M & W Technical Service Engineer show you—*right in your own plant*—how easy these PLATELUSTRE coatings are to use, and what striking effects they produce. Or, if you prefer, write for free literature.

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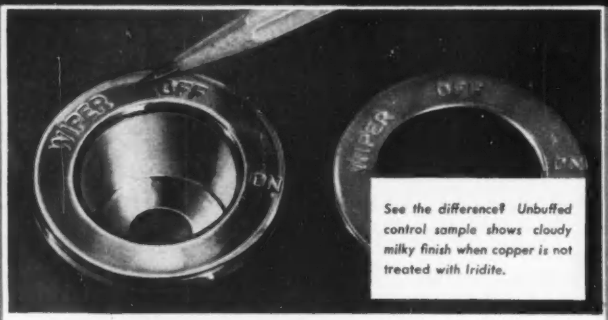
LOOK— what you get WITHOUT BUFFING



See the difference? Unbuffed control sample shows cloudy milky finish when copper is not treated with Iridite.

with IRIDITE® Metcote in COPPER-CHROME FINISHING

This sparkling bright finish is the result of just a simple dip in Iridite Metcote between the copper and chrome plating cycles! You actually get the clear, bright appearance of copper-nickel-chrome because the Iridite treatment gives maximum brilliance and clarity to the copper undercoating.

FORGET BUFFING COSTS, PR PLATING! Once you've properly prepared the base metal . . . steel sheet or zinc casting . . . you can completely forget buffing costs because no further buffing is required! And, there is no need to resort to PR plating or extra brightener in the copper plating solution because of the chemical polishing action of Iridite Metcote. The result? A pleasing clear, sparkling bright finish that is ideal for decorative products.

PROVE IT YOURSELF! Send us samples of your product for test-processing with copper, Iridite Metcote and chrome. Then make your own inspection and tests. Once you've seen your own product treated with this Iridite finishing system you'll never go back to slower, more costly buffing for your bright finishing. Start saving money *now*—write us direct or call in your nearest Iridite representative. Look under "Plating Supplies" in your classified telephone directory.

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all subscribers is certainly a forward step, since we are considerably troubled by the constant request from our engineers who receive direct mail offers of such bound volumes, but are ineligible because they are already subscribers. —J. E. LOCKHART
Reeves Pulley Co.

Correction For "Stress in Rotating Disks . . ."

To the Editor:

In going over your article "Stresses in Rotating Disks of Nonuniform Thickness" by Messrs. Gawain and Curry on page 152 of the July 1951 edition, I noticed what appears to be a misprint.

In the equation 4C, the subscript with the letter L should be t instead of r, making the equation:

$$\Delta\sigma_t = -(D\ L_t)S \quad \ldots\ldots\ldots\ldots (4C)$$

If there are reprints of this article available, I would like to have one very much. —JOHN FERGUSON
Eclipse-Pioneer Div.
Bendix Aviation Corp.

Author's Efforts Rewarded

To the Editor:

We are very much interested in the article appearing in the February, 1951 issue of PRODUCT ENGINEERING on the subject of reinforced plastics.

We would appreciate knowing how we might get in touch with the author, Mr. Richard J. Francis. We are interested in the possibility of considering him as a consultant in a program of development, using plastic impregated fiber glass. —D. MAPES
Walter Kidde & Co., Inc.

Ed—We are very glad to hear that you are interested in contacting Dick Francis as a consultant on a program you have under development on plastic impregated fiber glass.

His address is as follows: Mr. Richard J. Francis, 105 So. 33rd St., Newark, Ohio.

Needs Special Paddle Wheel

To the Editor:

I am engaged in the design of mechanical equipment required for a new plant to be built in Saskatchewan early next year for the fabrication of insulating board from waste straw, by a new patented chemical and mechanical fabricating process.

I have a problem in locating a source of supply for a special mixing paddle

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assembly required for this plant. The mixer is to fit inside a 6 ft wide concrete tank with curved bottom where the shredded straw fibres in a chemical solution are thoroughly mixed before conveying to the fabrication machine proper.

This mixer consists of a horizontal-rotating paddle assembly with 8-6-in. deep blades set at 45 degree spacing of 3 ft 8 in. O.D.; and a battery of 5 vertical-reciprocating paddles with 30 degree movement mounted on stationary vertical shafts inside the path of rotation of the paddle assembly.

From the above description you will appreciate that this is not a standard or even similar-to-standard design; and so far I have not found data on any standard line of mixers or agitators which could be adapted to perform equivalent service. I would gratefully appreciate suggestions from any of your readers as to possible sources of fabrication or supply of this mixer assembly. Also I would be happy to supply assembly and component part detail drawings to any interested manufacturers of this type of equipment for study and possible quotation. —WARREN J. MACIVER
Montreal, Quebec, Canada.

"Circular Nomogram . . ." Article Appreciated

To the Editor:

In the August issue of PRODUCT ENGINEERING, pages 152 through 156, is the article, "Circular Nomogram Theory and Construction Technique", by Edward C. Varnum of the Barber-Colman Company. We found the article very interesting and informative.

Therefore we are writing to see if you have any reprints of it available, and if so, we would appreciate receiving a copy. —H. A. DECENZO
U. S. Naval Ordnance Test Station

For Details on Optical Flat Making

To the Editor:

Reference is made to an article in the July 1951, issue of PRODUCT ENGINEERING, page 155, entitled "Contour Mapping of Optical Surfaces with Light Waves".

Additional information on the use of hard-coated precision optical flats is requested. Am I correct in the belief that the hard-coating of a flat increases its accuracy, and that a coated lap will show minor differences of flatness, but an uncoated one will not?

I would also appreciate a list of

materials that have been found suitable for coating optical flats. Have there been any differences noted in the results when laps of different materials were used, such as plate glass, "Pyrex" glass, or fused quartz? I am presuming that such laps are hard-coated with a vacuum process quite similar to that used in the coating of camera lenses with a non-reflectance coating.

I am interested in the production of such coated optical flats, rather than in the purchase or use of one.

—MYRON E. WOOD
Portland, Oregon

Ed—For additional information on optical flats write to Mr. T. B. Saunders, Optical Instrument Lab., National Bureau of Standards, Washington 25, D. C.

African Engineer Wants American Publications

To the Editor:

As I am about to be an engineer. I shall be very glad if you will send me engine books. I am now learning fitting. Please send me more pictures and an address book. I want to be friends with you sir. Please send me PRODUCT ENGINEERING.

Nothing more to say than my best wishes to you and all your friends.

—ALEX ASAH NTIM, ESQ.
Presby School, Obosomase
Nr Aburi, Akuapem
Gold Coast, West Africa

Ed—You have directed your inquiry for information on fittings to the wrong McGraw-Hill publication. PRODUCT ENGINEERING is entirely a machine design paper. We suggest that if pipe fittings, etc., are your primary concern you contact the magazine *Power* at the same address.

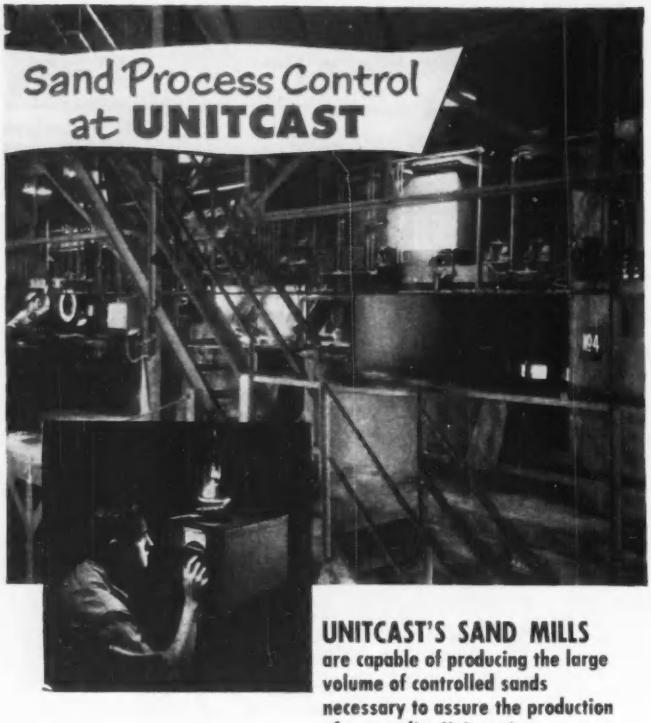
Enclosed is a subscription blank to PRODUCT ENGINEERING. We don't know if our foreign subscriptions are filled at the moment, but you may be able to subscribe to the magazine.

We are also enclosing a copy of the McGraw-Hill Book Company catalog, listing their available publications for your information.

Help Found In "Control . . . Design Changes" Article

To the Editor:

The article "Controlling Engineering Design Changes" appearing on pages 119-122 of the September 1951 issue of PRODUCT ENGINEERING is a unique contribution. In my work in



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Engineering Standards, these problems are real.

I would appreciate having you supply 24 reprints of this article, if convenient, and permission to reproduce portions for our own organization.

—IRWIN S. BOAK
The Gray Mfg. Co.

Ed—Our guess was that the popularity of this article would be high, but we did not anticipate the terrific number of requests that have come in for it. Consequently, we do not have a thing available in the way of tear sheets or reprints.

You have our permission to have this article photostated or planographed. We are sorry that we cannot help you.

Ceramic Coating For High Temperatures

To the Editor:

Would you please send me the address of the Solar Aircraft Company, who have developed the new ceramic coating for high temperature uses as described in your PRODUCT ENGINEERING, September 1951, page 194.

—A. ECKSTEIN
Ace Engineering Co.

Ed—The Solar Aircraft Company, who developed the new ceramic coating mentioned in your letter, can be reached at San Diego, Calif.

Plastic Diaphragm Material

To the Editor:

We are making this investigation for a client who manufactures a plastic material which he believes is much superior to anything used at the present for diaphragm controls, and he wants to find out who the companies are who would be interested in this material. If you could give me a few sample names of such companies, I could then refer to some directory and find other names in the same classification.

To make sure that you understand the situation, we want to emphasize that our client does not propose to manufacture any instruments or even the control assembly. He merely wants to sell the plastic material which will be used in the control.

If you cannot supply me with the necessary information, perhaps you can suggest someone who can.

—GEORGE T. METCALF
George T. Metcalf Co.

Ed—We suggest that you refer to

ANCHOR

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This clamp-type coupling is widely used on equipment subjected to rough going. For example, many earthmoving and oil-field equipment manufacturers standardize on Anchor to assure maximum dependability under the toughest possible conditions. This is the coupling for you, too — the coupling with the grip that stops complaints. Write today for catalog of sheets giving size tables and recommended working pressures.

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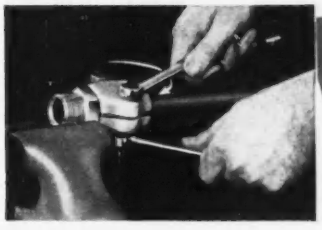

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Thomas' Register of American Manufacturers. In the fortieth edition, columns 4692 and 4694, are listed approximately 100 or so companies who actually manufacture diaphragms of one type or another. Some of these are listed under metallic diaphragms, such as Clifford Mfg. Co., Fulton-Sylphon Div., Robertshaw-Fulton Controls Co. of Knoxville, Tenn., and Gasket Packing and Specialty Co. Main breakdowns include ceramic diaphragms, fuel pump, leather, mica regulator, and rubber diaphragms, and so forth.

Chief Gear Engineers

To the Editor:

Would you be able to supply me with a list of the names of the Chief Engineers of each of the companies listed on the attached sheet.

I will greatly appreciate your assistance. —T. L. SANDERS
The Hoover Co.

Ed—The chief engineers of the gear companies that you listed are on the attached sheet: Mr. O. W. Klima, Ch. Eng., Abart Gear & Machine Co., 4835-39 West 16th St., Chicago, Ill.; Mr. H. M. Koelliker, V. P., Chicago Rawhide Mfg. Co., 4835-39 West Ave., Chicago, Ill.; Mr. B. S. Nelson, Ch. Eng., Foote Bros. Gear & Machine Corp., 4549 So. Western Ave., Chicago, Ill.; Mr. Warren G. Jones, V. P., W. A. Jones Foundry & Machine Co., 4405 West Roosevelt Rd., Chicago, Ill.; Mr. H. Walter Regensberger, Ch. Eng., Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.; Mr. A. H. Gilbert, Ch. Eng., Brad Foote Gear Wks., Inc., 13th and South Cicero Ave., Cicero, Ill.; Mr. J. Y. Dahlstand, V. P., Universal Gear Corp., 1400 East 19th St., Indianapolis, Ind.; Mr. J. J. Lannon, Pres., Grant Gear Wks., Inc., 157 West Second, Boston, Mass.; Mr. M. T. Schumb, Ch. Eng., Boston Gear Wks., 3200 Main St., North Quincy, Mass.; Mr. Clem, Rice Barton Corp., Worcester, Mass.; Mr. R. W. Sumen, Ch. Eng., Link-Belt Co., 5938 Linsdale Ave., Detroit, Mich.; Mr. Joseph Royer, The Medart Co., 3502 DeKalb St., St. Louis, Mo.; C. H. Van Deusen, Pub. Rel., Gifford-Wood Co., 23 Hill St., Hudson, N. Y.; Mr. G. H. Acker, Cleveland Worm and Gear Co.; 2250 East 80th, Cleveland, Ohio; Mr. Robert Suman, Ch. Eng., Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; Mr. A. E. Hohman, Adv. Mgr., Lewis Foundry & Machine Div., Blaw-Knox Co., Pittsburgh, Pa.; Mr. Thompson, Mesta Machine Co., P. O.

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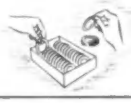

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To the Editor:

In connection with an engine test manual which we are preparing for publication, I wish to request permission to reproduce the following illustrations from McGraw-Hill publications: Moyer—*Power Plant Testing*, 1934, Fig. 163 and 170; Rhodes, T. J.—*Industrial Instruments For Measurement and Control*, Fig. 77; Shoop & Tuve—*Mechanical Engineering Practice*, 1941, Fig. 14; Snell & Biffin—*Commercial Methods of Analysis*, 1944, page 47, drawing of Westphal balance; Norton—*Lubrication*, 1942, Fig. 26 and 29.

McGraw-Hill Magazines: *Chemical & Metallurgical Engineering*, May, 1943, page 113—drawing of tilting trap fluid meter, float type meter, mercury float, floating bell and bellows device; PRODUCT ENGINEERING, April, 1948, page 125, photograph of polariscope.

In the event that any or all of these are used in the final version, we shall, of course, give McGraw-Hill credit.

—IRVING J. ROCK
Research Laboratories Div.
General Motors Corp.

Ed—Permission is hereby granted by the McGraw-Hill Book Company for use of the following material from McGraw-Hill titles: Moyer—*Power Plant Testing*, Figures 163 and 170; Shoop & Tuve—*Mechanical Engineering Practice*, Fig. 14; Snell & Biffin—*Commercial Methods of Analysis*, page 47, drawing of Westphal balance; Norton—*Lubrication*, Fig. 26 and 29.

Use of this material is, of course, limited to inclusion in the engine test manual that your department is preparing for publication.

We cannot authorize the reproduction of Fig. 77 appearing in Rhodes' *Industrial Instruments For Measurement and Control*. As you will note from the courtesy line in the caption this was obtained from the Leeds and Northrup Company and reused in our book with their permission. It will be necessary for you to obtain the necessary authorization from Leeds and Northrup to use the illustration.

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Ed—We discard all article overmatter including illustrations approximately six months after it is published. We cannot help you.

We suggest that you contact Mr. A. R. Anderson of the Anderson-Fluke Corp. who makes the polariscope.

Journal Bearing Design

To the Editor:

We are anxious to obtain information and publications that are available pertaining to "Design of Journal Bearings". —STEVE BARKER, JR.
Monolith Portland Cement Co.

Ed—The most comprehensive job that PRODUCT ENGINEERING ever has done on journal bearings appeared in the October, 1948, issue. This was a 32-page insert which took us a couple of years to compile and because of the demand for reprints, we are absolutely out of print on this insert. We suggest that you get the bound volume of PRODUCT ENGINEERING and have photostatic copies made of the insert.

We suggest a book by Max and Shaw on "Design Journal Bearings."

Inventor of "Delta" "O" Ring Combination

To the Editor:

In your February 1945 issue, page 102, Mr. Howard Field, Jr., describes a delta ring in combination with an "O" ring, in Figure 11.

He notes that the combination is patented.

We would like to know the patent number, inventor or assignee. If you cannot help, will you kindly forward Mr. Field's address so that we may contact him directly.

—JOHN C. MONAHAN
Hydraulic Accessories Co.

Ed—The last address we have in our files for Howard Field, Jr., is 5959 Hoover Street, Los Angeles 44, Calif.

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5/8"	.065"	16	.028"	22
3/4"	.065"	16	.028"	22
7/8"	.083"	14	.028"	22
1"	.109"	12	.028"	22
1 1/8"	.109"	12	.028"	22
1 1/4"	.134"	10	.028"	22
1 3/8"	.134"	10	.028"	22
1 1/2"	.148"	9	.035"	22
1 5/8"	.148"	9	.035"	20
1 3/4"	.148"	9	.035"	20
1 7/8"	.165"	8	.035"	20
2"	.165"	8	.035"	20
2 1/4"	.180"	7	.035"	20
2 1/2"	.203"	6	.035"	20
2 3/4"	.203"	6	.035"	20
3"	.220"	5	.049"	18
3 1/4"	.220"	5	.049"	18
3 1/2"	.238"	4	.049"	18
3 3/4"	.238"	4	.049"	18
3 7/8"	.238"	4	.049"	18
4"	.238"	4	.049"	18
4 1/4"	.250"	4	.049"	18
4 1/2"	.250"	3	.049"	18
4 3/4"	.250"	3	.065"	16
5"	.180"	7	.083"	14
5 1/2"	.180"	7	.083"	14
			.083"	14

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NEW BOOKS

Machine Drawing

DEANE LENT, *Assistant Professor of Engineering Drawing, Department of Mechanical Engineering, Massachusetts Institute of Technology.* 523 *pages,* 6 x 9 *in. Published by Prentice-Hall, Inc.* 70 *Fifth Ave., New York* 11, *N. Y.* $7.75.

The time and effort expended in developing good draftsmen is justified. In these days when science and engineering are so rapidly expanding, some educators are tempted to abbreviate fundamental courses (particularly those involving any manual skills) in their anxiety to include more advanced material in undergraduate study. The importance of drafting courses is no longer unchallenged and the vote of confidence from the practicing engineer is assuring.

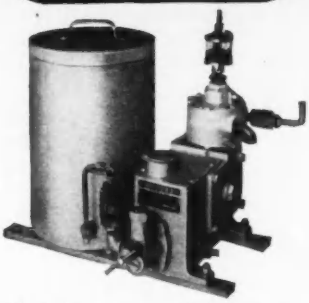
The statement that a graduate in engineering knows how, but not what, to draw, is a challenge. It is true that there is much to be learned in industrial practice which cannot be taught in any school, but should we rest the case for drafting instruction on "vocabulary" and technique alone? Drafting is principally concerned with the description of construction. If a draftsman is uncertain of the content of a drawing, it is generally because he is ignorant of the process of construction which the drawing is to explain. The education of a draftsman cannot be limited to drawing techniques. He must also know the methods by which structures and machines are built. In many schools, the drafting program is supplemented by other courses for this purpose, but the responsibility for the application of this knowledge rests squarely upon the drafting department.

The inability of a man to recognize his function in a project indicates that he does not understand the over-all plan of operations. The drafting unit is a planning department where a well-organized program of work is laid out for each undertaking. Drafting instruction must then also assume the responsibility of explaining practices and procedures of conducting a project from start to finish.

This book is written with the above thoughts in mind. It is devoted to machine drawing exclusively, offering complete material for both elementary and advanced courses in technical institutes, colleges or engineering schools.

The order of presentation follows

WHAT NEXT?
GAST rotary AIR MOTORS
run on gas pressure to drive liquid pumps!



Alert designers are still finding new ways to exploit the unique advantages of Gast Air Motors. Look at this example:

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RESULT: Dependable "free" power — low cost for motor.

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the program of the development of a machine from the design through the detail and assembly stages to the point of starting production. This arrangement is chosen because it serves both to orient and to interest the student in the project. However, the order of assignment is flexible and may easily be adapted to suit the needs of the class in question. For example, the discussion of the design stage, while purely descriptive, assumes some knowledge of projection, so that for a first course in drawing the assignment of this chapter can be postponed until projection has been studied. Similarly, in an advanced course, the elementary material can be bypassed, but it is available for reference when needed.

The effectiveness of an advanced course in detailing often hinges upon the proper presentation of elementary material. Consequently the fundamental drafting techniques, principles of projection and conventional representation are presented with great care in this text. A particularly thorough treatment of dimensioning is given, from basic rules through problems of mass production, with the accent on clearness and utility. Processes of manufacture are described with illustrations for constant reference.

Individual problems are offered in the elementary work and project problems in detailing and assembly drafting. Complete small machines in current production are used as material in the latter case, permitting the observance of actual drafting-room procedure in classes. Several exercises in reading drawings supplement the drafting problems.

The unusual amount of reference material in the appendix permits this book to serve as a draftsman's manual as well as a text.

Calculus and Analytic Geometry

GEORGE B. THOMAS, JR., *associate professor mathematics, Massachusetts Institute of Technology. 685 pages, 6 x 9 in. Published by Addison-Wesley Press, Inc., Cambridge 42, Mass.* $6.

This textbook has been tested for two years in classroom use at the Massachusetts Institute of Technology. As a result of this test, the book has been thoroughly revised.

Another complete revision is planned during the next two years after the book has been tried at other institutions. For this reason the present volume has been printed from plates prepared from copy produced by an

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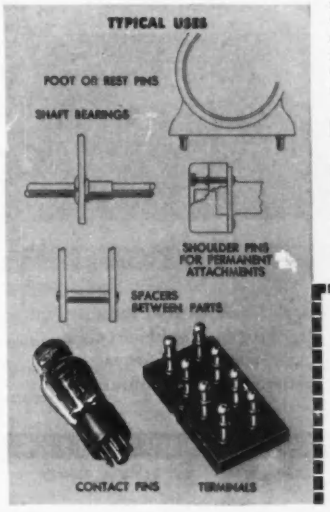

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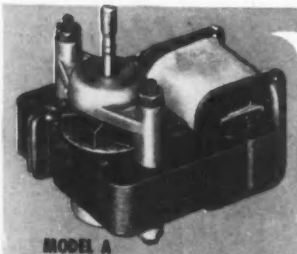

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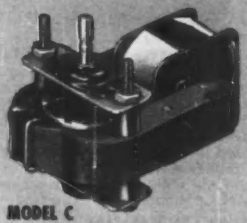

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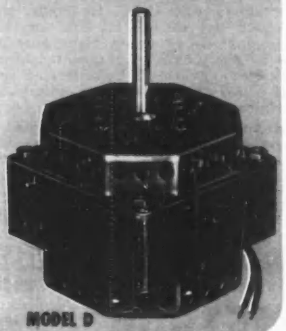

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automatic typewriter rather than from set type. It should be stated however that this book is perfectly readable and useful for its purpose.

The introductory chapters present the basic concepts of both differentiation and integration, and the applications of integration to physics. These are followed by chapters devoted to plane analytic geometry, polar coordinates, transcendental functions and hyperbolic functions.

The next major objective is a systematic study of integration, vectors and parametric equations.

Several of the topics covered in the remaining chapters on solid geometry and vectors, partial differentiation, multiple integrals, infinite series, and complex numbers and functions are frequently postponed until after a course in advanced calculus. These are included in this first course in calculus for two reasons. First, they are useful to the student in his study of physics and engineering; second, the more difficult ideas need repeating.

As a requisite to the study of this textbook the reader is expected to know high school algebra, plane and solid geometry, and trigonometry.

The Structure and Mechanical Properties of Metals

BRUCE CHALMERS. 222 pages, 6 x 9 *in. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $3.50.

This book provides a clear simplified picture of the structure of metals and alloys and its relation to the mechanical properties. The author has dispensed with involved mathematical consideration. A general elementary background in physics and chemistry and a knowledge of commonly used engineering terms are all that are necessary to thoroughly understand the text.

The forces that hold metallic atoms together are discussed and graphically described and the structures that may result from such forces are demonstrated.

The effects of alloying elements, mechanical deformation, and heat treatment on the structural phases in the metal are considered. The structure of a specific sample of a metal or alloy is presented in terms of the basic alloy structure and the manner in which it is modified by the treatment applied. A brief account is given of the ways in which the metal structure can be examined and determined.

Mechanical properties of the various

(Continued on page 280)

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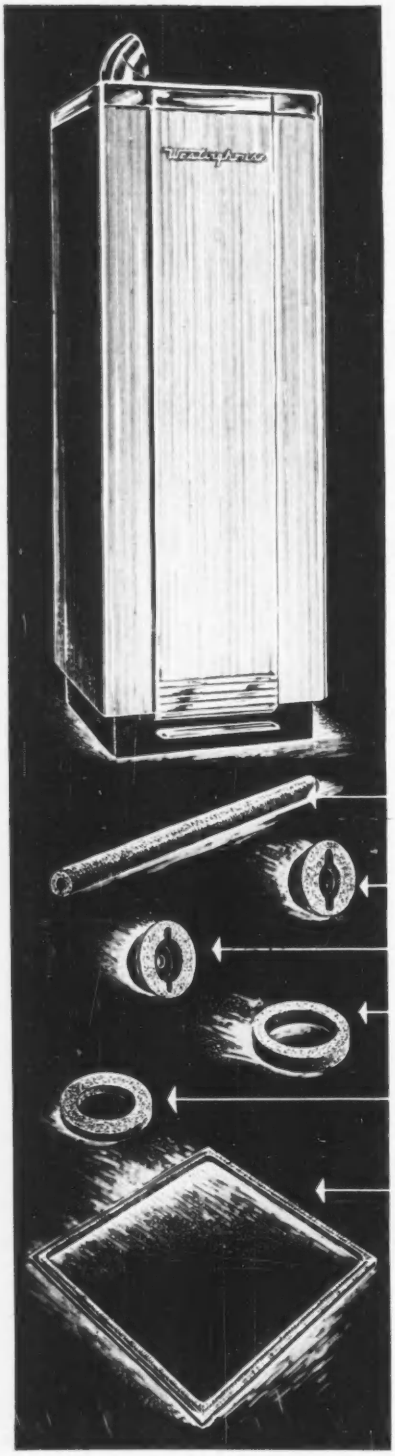

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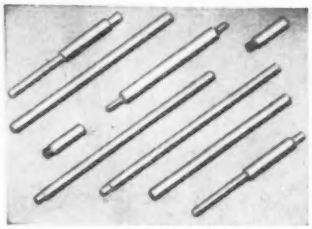

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metals and alloys are presented and discussed. The dependence of these properties on the metal structure is explained and illustrated by numerous examples.

To best illustrate the principles and effects under discussion, examples have been chosen for their aptness to the subject rather than for their practical usefulness. The data presented was not included for its particular technical usefulness. The book is intended primarily to give those engaged or interested in the manufacture or use of metallic materials an insight into the importance of structure to the performance of metals.

Automatic Feedback Control

WILLIAM R. AHRENDT, *President, The Ahrendt Instrument Co., Lecturer, University of Maryland and* JOHN F. TAPLIN, *President, Kendall Control Corp., Consulting Engineer.* 412 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co., Inc.,* 330 *W.* 42*nd St., New York* 18, *N. Y.* $5.

A practical and extensive book, this text is concerned with the analysis of automatic feedback control systems and the design or selection of required control apparatus. The material is divided into two parts: 1) a thorough discussion of the theory of automatic control, and 2) a detailed treatment of the types of problems encountered in each type of industry. Examples of the various classes of instruments are presented, showing both functional and constructional requirements. The author covers the field of servomechanisms, speed governors and temperature, pressure, flow and liquid level controls. Discontinuities and linearities are studied in considerable detail.

Prerequisite mathematical methods of analysis are presented in their simplest form, so as to be intelligible to the student with a minimal knowledge of higher mathematics. The theoretical treatment is further simplified by illustrating all important formulas by graphical charts and curves. The latter greatly assist the student in visualizing the more involved mathematical processes.

Particular emphasis is placed on the similarity between the control reactions in the separate fields of industry and science. The authors have selected terminology and symbols applicable to all fields without limitation. An entire chapter is devoted to the pneumatically operated control.

The treatment of temperature regulation is novel; the authors present concrete, quantitative figures which

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will permit the student to evaluate the actual thermal lags associated with the transmission of heat in a large number of thermal processes. Many problems are included to supplement the text.

Ten Thousand Commandments

HAROLD FLEMING, *Business Writer, 206 pages, 6 x 8 in., published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y., Hard cover.* $3.

Strange decisions in recent years by the Supreme Court of the United States has changed the interpretation of the nation's antitrust laws. As a result, lawyers have found it difficult to keep up with these changes, and businessmen have almost given up hope of ever understanding what the antitrust law now means, as interpreted.

This book is not for lawyers, but for people, the author says. But drawing a finer distinction, he says that it is about businessmen, and government lawyers. These men burn the midnight oil arguing about the interpretation of the law, and about such commonplace business practices as the offering of quantity discounts, the quoting of delivered prices, the cutting of prices to get more volume, and the excluding of competitors by "building better mousetraps."

It tells how the Federal Trade Commission and the Department of Justice, with the help of the Supreme Court have framed ten thousand confusing commandments for American business, and have begun to balk competition under the guise of protecting it. The author maintains that American business has developed in a business community that daily operates with quantity discounts, matched prices, freight absorption, horizontal and vertical integration, and the development of new products. Every one of these practices, if not an outright crime under Federal law, is now under a legal cloud.

The Great Atlantic-Pacific Tea Company antitrust case is brought up in several chapters, and how the word monopolize took on a strange new definition. Fleming contends that the Atlantic and Pacific was attacked, not for making so much money in their manufacturing divisions, but for making so little on retailing. In other words, the A & P did not charge enough for its groceries.

Fleming concludes by saying that the present situation involves a contradiction in American ways. The morals of the business community and the findings of the Federal courts are

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Clear Writing for Easy Reading

NORMAN G. SHIDLE, *Manager of Publication Div., SAE.* 176 *pages,* 6 x 9 *in., hard cover. Published by McGraw-Hill Book Co., Inc.,* 330 *W. 42nd St., New York* 18, *N. Y.* $3.

"To get ideas off the written page and into the readers' minds is the object of writing"—steps by which this objective may be accomplished are outlined and developed in this book.

The first four chapters explain the thinking processes that must supersede the actual writing. The principal points covered are: how to define your audience and express the "peg" or primary idea of your article. Use of one of the four general types of outlines presented is considered essential.

The methods by which organized thinking may be put to work are presented in Chapters V to X. Composition of good lead sentences, logical sequence of ideas, and the selection of words that "live" and create definite effects are also discussed.

Among the suggestions for easy-to-read writing developed from Chapters X to XV are: use a typewriter where possible and keep your copy neat; use punctuation first to make your writing easier to read and then to conform to academic rules. Hints for news reporting, secretarial writing, and technical reports are presented. Methods of expressing congratulations and offering condolences are included.

Chapter Fifteen is composed of examples of writing and an analysis of each example.

At the end of Chapters III, IV, V, and VI are the exercises for practicing points stressed, and on page 153 there is a calculator for judging reading ease. An index is given for reference to pertinent subjects in the book.

Programs For An Electronic Digital Computer

MAURICE V. WILKES, *director of the mathematical laboratory, University of Cambridge, England;* DAVID J. WHEELER, *and* STANLEY GILL. 170 *pages,* 6 x 9 *in. Published by Addison-Wesley Press, Inc., Cambridge* 42, *Mass.* $5.

The methods of preparing programs for the EDSAC (Electronic Delay Storage Automatic Calculator) described in this book were developed

with a view to reducing to a minimum the amount of labor required, and hence of making it feasible to use the machine for problems that require only a few hours of computing time as well as for those that require many hours.

This objective necessitated the establishment of a library of subroutines and the development of systematic methods for constructing programs with their aid.

The process of building up such a library of subroutines, and testing its value by practical use, appears to have proceeded further at the Mathematical Laboratory of the University of Cambridge than elsewhere. In this book the authors, who together have been primarily concerned in this development, give an account of the present state of this aspect of the study of means of using an automatic calculating machine effectively. It is the result of considerable exploratory work on such matters as ways in which to specify operating instructions to the machine, and to draw up subroutines, so as to give the required flexibility, ways in which to enter and leave subroutines, and different types of subroutines.

These methods are described in terms of the code of orders used in the EDSAC, but for the main part they may readily be translated into other codes.

It is hoped by the authors, that those who have charge of similar machines, or who are faced with the task of putting a new machine into operation, will find some of the ideas and methods presented to be of assistance. It is hoped also, that the book will be of use to those who wish to know something about the form in which problems are presented to an automatic digital calculating machine, and who wish to assess the possibilities of the application of such machines to their own subjects.

Manufacturing Equipment And Processes

CHARLES W. LYTLE, *professor of industrial engineering, New York University; and* ARTHUR F. GOULD, *associate professor of industrial engineering, Lehigh University;* 750 *pages,* 6 x 9 *in. Published by the International Textbook Co., Scranton* 9, *Pa.* $6.50.

This third edition is virtually a new book, because the authors have sought to present all basic advances within the scope undertaken, and recent advances have been tremendous. Never-

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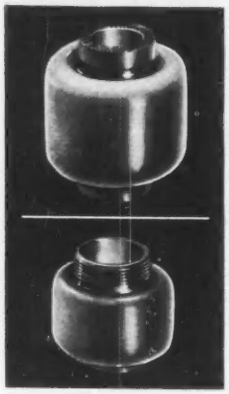

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theless the book is an outgrowth of its predecessor, Factory Equipment, by Dr. Joseph W. Roe and the present senior author.

As in Factory Equipment, the treatment is selective rather than comprehensive, and explicit on principles rather than exhaustive on operating details. The objective has been to present the kind of knowledge that an engineer needs in deciding what processes and machines will best meet any set of requirements. With this purpose in view, principles are stressed, limitations in applications are pointed out, and economic considerations are discussed. It is conceived that most engineers face problems of process and equipment selection; not merely engineers in the machine-tool industry, but those in any kind of manufacturing, large or small.

American manufacturing today tends to operate on a large scale, but there are also many medium- and small-sized establishments. These smaller companies may use very few special-purpose machines, but they frequently contract for certain parts from other establishments that do use them. Hence the more important special-purpose equipment is described, and comparisons are made between the general-purpose and special-purpose types. In fact, this book shows how special-purpose equipment is usually an integration of general-purpose units which have been standardized and co-ordinated for some particular job.

The scope of the book is broad, partly because no college attempts to offer a separate course for each of the processes that are included, and partly because the divisions of the subject matter are closely interrelated. In studying machine tools, for instance, it is important to have a basic understanding of heat treatment, quality control, and economy. These in turn affect design. Then there are always the problems of using die castings or plastics, precision castings or products of powder metallurgy, large castings or forgings built up by welding. This book introduces the young engineer to all these and other fundamental processes and makes it possible for him to compare the advantages of one with those of another.

Besides discussing basic types of hot and cold working machines and many special-purpose types of machines, the authors present the basic principles and techniques of casting, soldering and brazing. Thus the text can do much toward giving engineers a better understanding of the practical aspects of his profession. At the end of each chapter is a list of questions suitable for review and examination.

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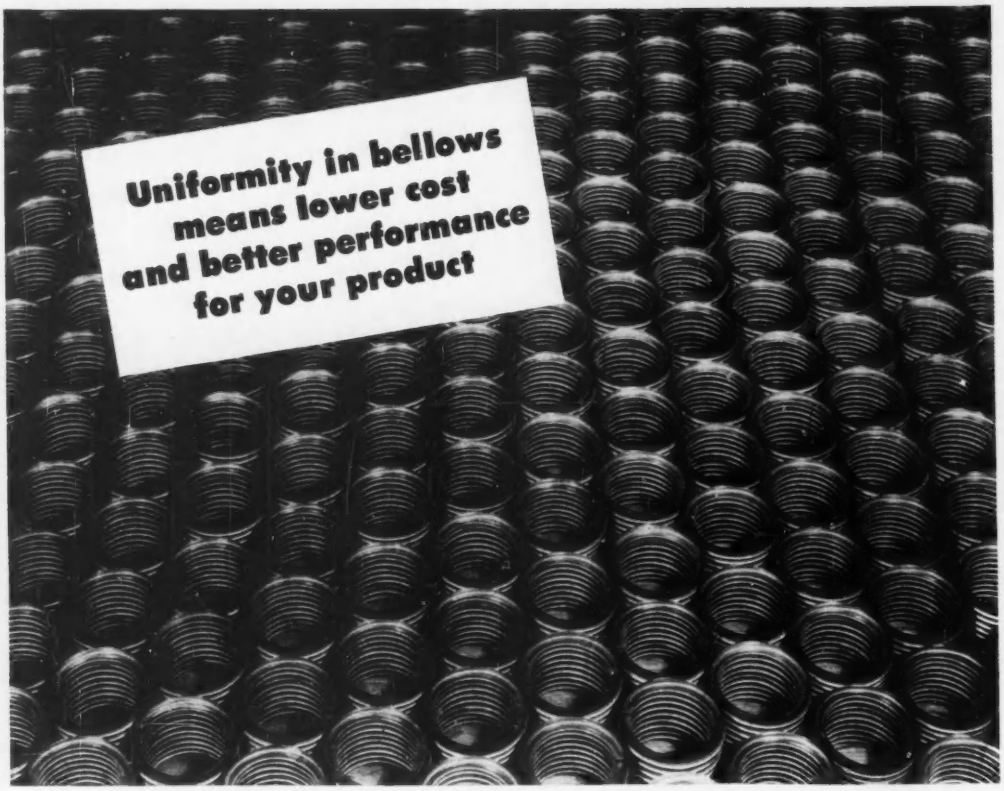

Advanced Manufacturing Techniques assure high standards of uniformity in *Flexon Bellows*

When the performance of your product depends upon a bellows, it will pay you to take advantage of the manufacturing skill that goes into every Flexon Bellows. Through advanced manufacturing techniques Flexon Bellows offer that rare combination of high uniformity and exact conformance to your specifications at competitive prices. For the manufacturer it means the better product performance and easier assembly that goes with uniformity and high quality at lower ultimate cost.

Flexon Bellows can be made in a complete range of sizes in stainless steel, brass or bronze to meet your specifications. If you will send an outline of your requirements, including a print, if possible, we will be pleased to send you full data on the proper Flexon Bellows to fill your needs.

The Flexon Bellows catalog gives details on bellows application for the designer. If you do not already have your copy, write for one today.

Flexon identifies CMH products that have served industry for over 49 years.

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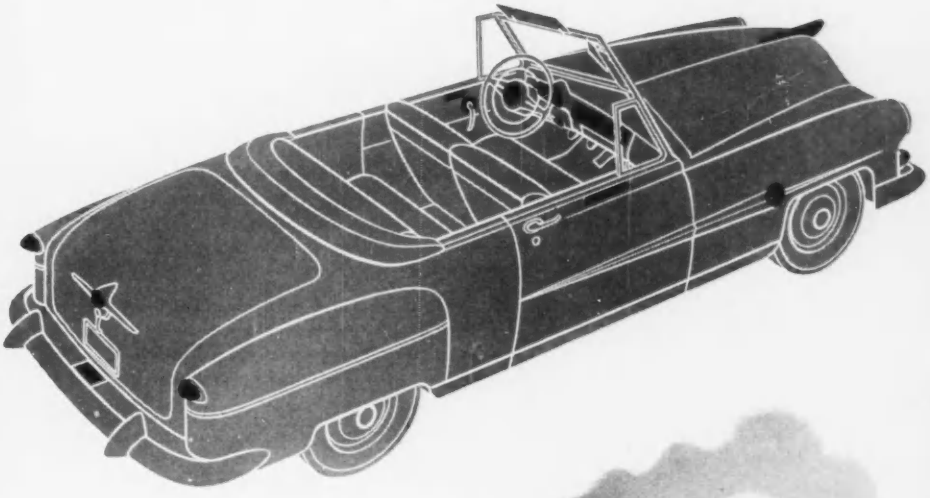
All around the car...



PLEXIGLAS

Oldsmobile Tail Light Lens—a typical PLEXIGLAS part on 1951 cars. Molded by Guide Lamp Division of General Motors, Anderson, Indiana.

In more and more places on today's cars, you'll find PLEXIGLAS acrylic plastic molded parts. Especially where *functional beauty* is needed! PLEXIGLAS tail light and stop light lenses, front and rear medallions, instrument panels, parking light lenses, hood and steering wheel ornaments, decorative bezels and escutcheons, speedometer, radio, clock and gauge dials—all are being used on the nation's 1951 and 1952 motor cars.

PLEXIGLAS molded parts have gem-like sparkle, rich color, resistance to breakage and heat—*plus* excellent dimensional stability and outstanding resistance to weather. PLEXIGLAS permits economical production of identical parts in large quantities. Write for our booklet showing typical parts molded from PLEXIGLAS acrylic plastic molding powders.

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PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.*

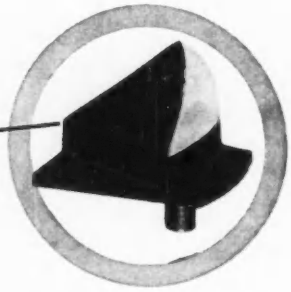
Production Costs of Vending Machine Parts Cut 66%

Investment-Cast Surfaces Ward Off Bacteria and Abrasion

A newly developed fruit juice dispenser is equipped with a stainless steel can opener punch to resist the corrosive effects of the juices, and to avoid metallic contamination of the liquids. By using HAYNES investment castings, the manufacturer gets the points and shafts of these units at one-third the cost of machined parts.

Besides being economical, the investment-cast parts have exceptionally sound structure and smooth surfaces. Thus there are no flaws or crevices that might afford refuge for bacteria. This fine surface finish protects the unit from abrasive wear, and maintenance costs are kept down. The original punch shows no wear after a full year's service.

For information on designing parts for investment casting, write for the booklet, "Design Factors in Investment Casting."



This investment-cast can opener point withstands the abrasive and corrosive effects of puncturing cans of tomato, apple, or citrus fruit juices.

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TRADE-MARK
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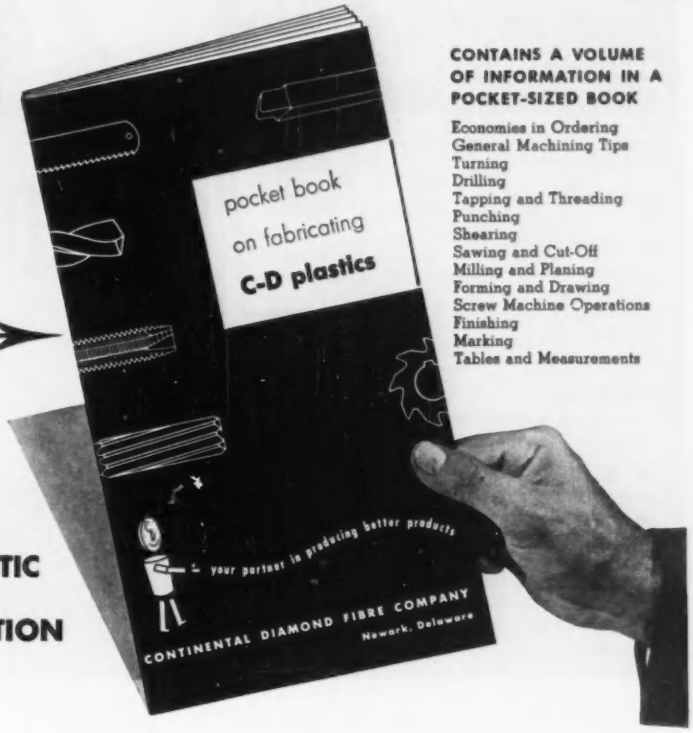

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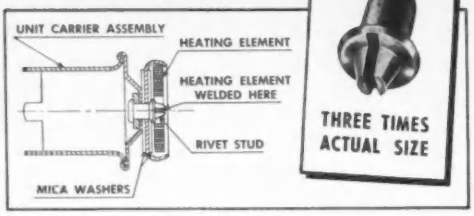

Small enough to put under your fingernail, this rivet is made by Progressive for The Cuno Engineering Corporation. Used in an automotive cigarette lighter, it serves as a post to which the center of the heating coil is spot welded and as a rivet for fastening the burner cup to the lighter shell.

This double function required precise upsetting of a metal sufficiently soft to be used as a rivet, yet rugged enough to withstand the welding operation.

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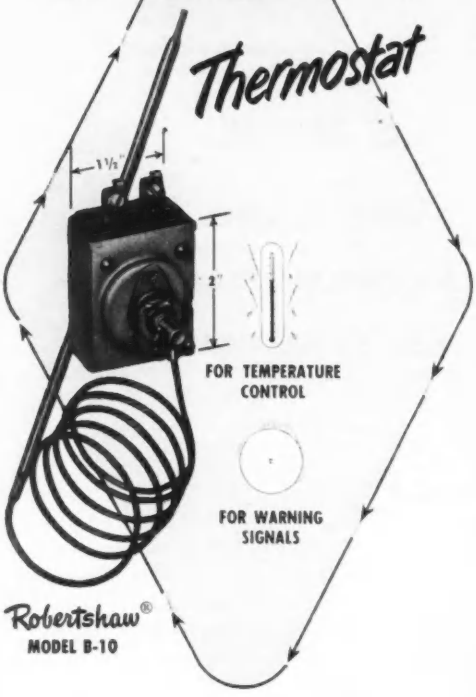

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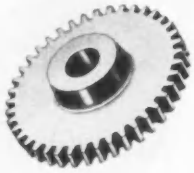

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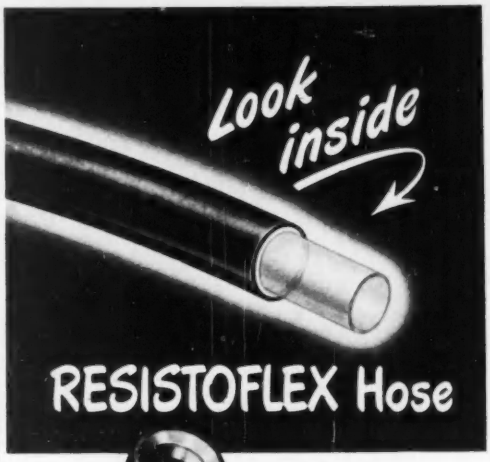

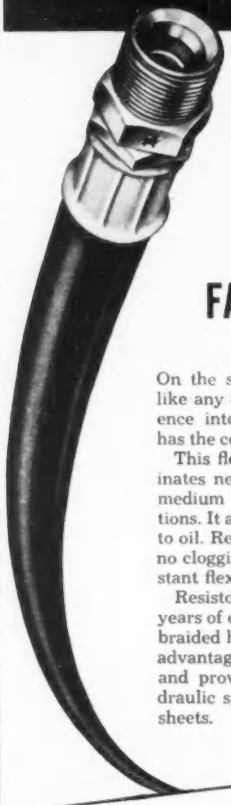

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On the surface, Resistoflex hose looks like any other hose. But what a difference internally. Only Resistoflex hose has the compar tube.

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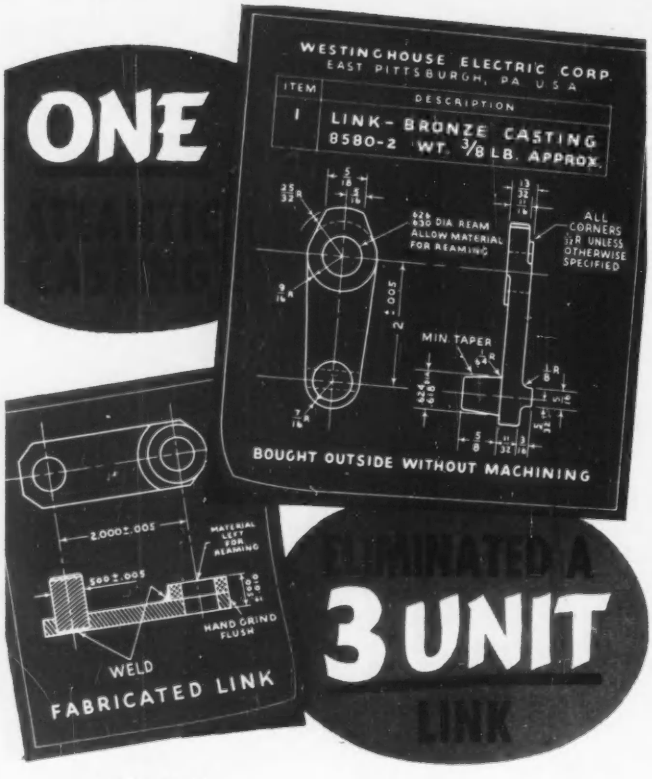

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Westinghouse Electric Corp. recently required a part for use on oil circuit breakers. Their rough blueprint called for a link composed of three separate units which had not only to be machined, but welded together.

Atlantic's engineers suggested a design that resulted in a part cast in ONE PIECE from Atlantalloy #31 High Tensile Manganese Bronze . . . a dependable engineering material that is stronger than many steels. This one piece casting eliminated the involved machining, welding and finishing steps—and consequently afforded a substantial saving over former costs.

Write for a copy of "Quality Precision Castings for Industry" today. This booklet shows how the plaster mold process cuts production costs and includes specifications on Atlantic's alloys.

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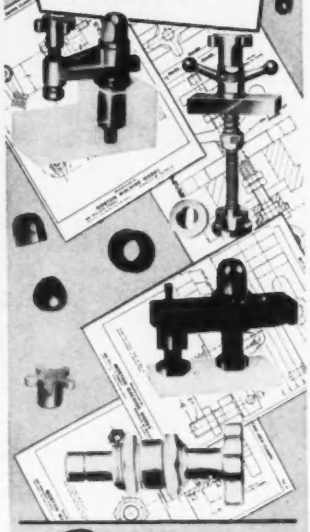

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Recognized throughout the industry for the development and manufacture of the most economical and highest quality Fixture Clamps and Standard Details. All precision made of heat treated selected steel • • • • • • • in a wide range of sizes and types to fit the most rigid and exacting requirements. . . . Complete Clamp Assemblies or any of their Component Parts.

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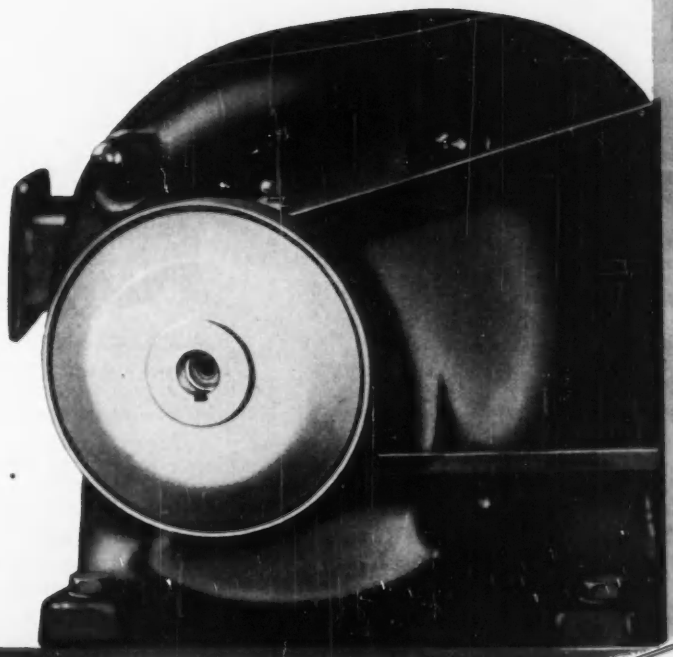

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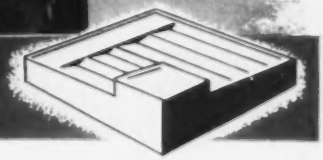

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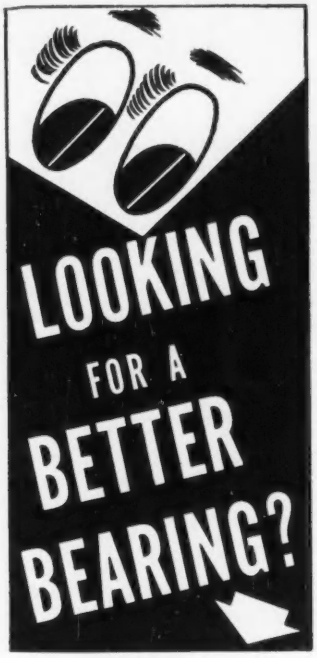

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Machined or Rough Cast of the Specific Formula Best Suited to the Application.

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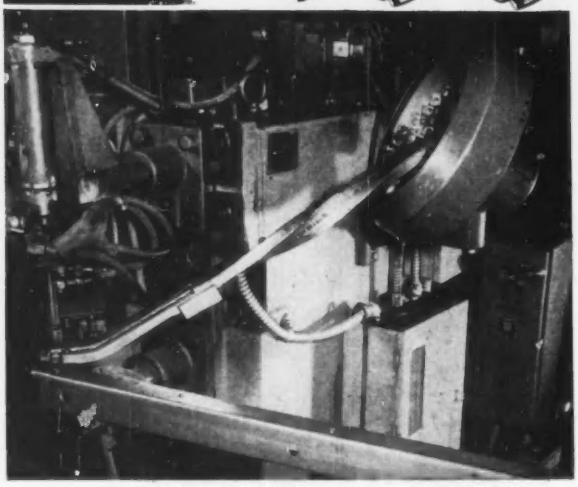
Here's a Faster Method in Assembly of Metal Parts



With MIDLAND WELDING NUTS

The photograph above shows a welding machine with an automatic hopper feed for welding three nuts to a channel member. This set-up provides high speed and low cost in assembling nuts in place.

In turn, the operation of attaching part to the channel member is speeded up through the convenience of Midland Welding Nuts.

For speed and economy in assembling you can't beat Midland Welding Nuts. Particularly useful in positions difficult to reach. Write or phone today for complete information.

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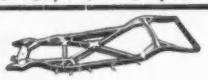

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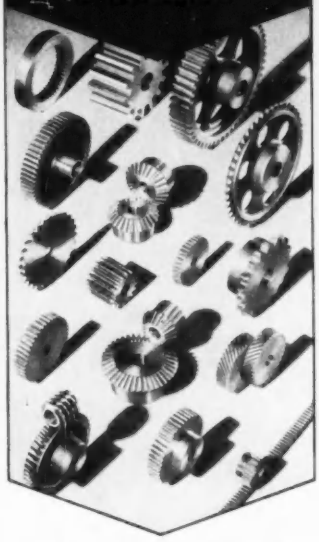

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This complete line of stock gears includes brass, bronze, steel, semi-steel, cast iron and non-metallic gears of every industrial type.

If you do not know the name of the nearest authorized American Stock Gear Distributor, write us.

Be sure to have ASG catalog 300 handy for ready reference . . . If you don't have a 1951 edition—ask for a free copy without delay.

AMERICAN STOCK GEAR
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Customer Reports:

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A manufacturer of packaging machinery tells of saving 20% in production time and 20% in material cost when he makes shaft bearings and nuts of Asarco Continuous Cast Bronze.

The patented Asarco casting process guarantees him bronze rod that is free from the hard and soft spots so often found in sand cast bronzes. Stock is exceptionally uniform and free from porosity. Since sand is not used, and dirt and dross are excluded, there can be no surface or internally trapped abrasive to dull tools or discourage high cutting speeds. Rejects are virtually unknown.

Dimensions are held to extremely close limits. For example, tube concentricities are within 1.5% of wall thickness. Dimensional uniformity is assured . . . machining on automatics is standard practice.

Continuous Cast Bronzes can be made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ on special arrangement.

216 sizes of standard Asarcon 773 bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in all principal cities. Distributors will cut this stock long or short to suit your needs.

ASARCO CONTINUOUS-CAST RODS TUBES SHAPES ®

Send for this free catalog on Asarco Continuous Cast Bronzes. It contains physical properties, table of weights, photomicrographs, table of stock shapes and sizes and other data.

West Coast Sales Agent:
KINGWELL BROS. LTD., 444 Natoma Street, San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana

for SAFE, SURE SERVICE SPECIFY CHIKSAN

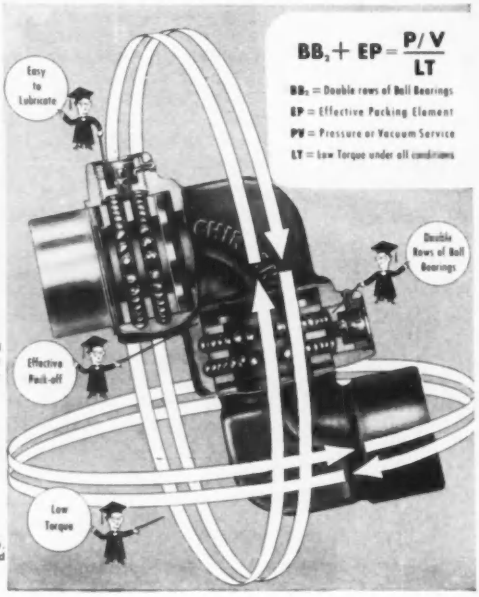
Standard Swivel Joints. For pressures from 125 psi. to 15,000 psi.

High Temperature Swivel Joints. For temperatures to 500°F. M.W.P. 700 psi.

Rotating Joints. For 150-lb. steam, brine, etc. Adopted for siphon return line.

Sanitary Swivel Joints. For Food Processing, Dairies, Bottlers, etc.

Hydraulic Swivel Joints. For pressures to 3,000 psi.


$BB_2 + EP = \frac{P/V}{LT}$
BB_2 = Double rows of Ball Bearings
EP = Effective Packing Element
PV = Pressure or Vacuum Service
LT = Low Torque under all conditions
Easy to Lubricate
Double Rows of Ball Bearings
Effective Pack-off
Low Torque

For over a quarter-century, here at CHIKSAN, we have specialized *exclusively* on developing and designing Swivel Joints* for all purposes . . . on manufacturing them to our rigid standards of precision . . . and on following through in the field to check performance under all sorts of conditions. That's why there is no substitute for CHIKSAN *Ball-Bearing* Swivel Joints* when it comes to efficient service with maximum safety . . . longest life . . . and minimum maintenance.

It costs you nothing to take full advantage of CHIKSAN's *specialized* experience. CHIKSAN Engineers will gladly cooperate with you in designing flexible lines to meet your specific requirements.

WRITE FOR CATALOG NO. 50-C. REPRESENTATIVES IN PRINCIPAL CITIES—SOLD BY LEADING SUPPLY STORES EVERYWHERE

*For full 360° rotation in 1, 2 and 3 planes. Unlimited flexibility in pipe lines is secured merely by arranging swivels in proper sequence. Over 500 different Types, Styles and Sizes for pressures to 15,000 psi; temperatures to 500°F.; pipe sizes from ⅛" to 12" and larger.

CHIKSAN TRADE MARK

CHIKSAN COMPANY
AND SUBSIDIARY COMPANIES
Chicago 3, Ill. BREA, CALIFORNIA Newark 2, N. J.
WELL EQUIPMENT MFG. CORP. HOUSTON 1, TEXAS
CHIKSAN EXPORT CO. BREA, CALIFORNIA NEWARK 2, N. J.

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

Superb CASTELL Prints

NO LONGER A LUXURY

CASTELL DRAWING PENCIL 9000

CASTELL LOCKTITE REFILL HOLDER 9400

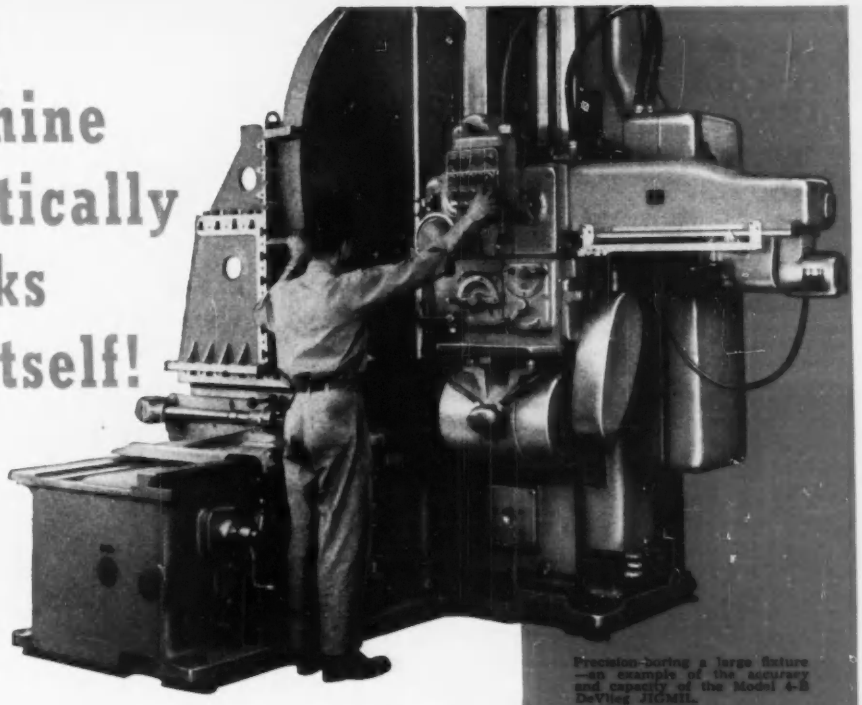
Famous CASTELL Drawing Pencil with Imported Lead now available to you at practically no extra cost

"Industry demands legible prints—and the making of legible prints begins on the drawing board," states Mr. E. S. Fairley, of the well-known B. K. Elliott Company, Pittsburgh, Cleveland, Detroit.

We agree with him 100%. Imported CASTELL Lead *always* has produced more sharp copies per original drawing than any other pencil on the market. New price ranges now bring CASTELL with imported lead within reach of craftsmen who heretofore used ordinary drawing pencils. You, too, may now enjoy the use of the world's finest drawing pencil at no extra cost. See your Dealer today.

A.W. FABER-CASTELL PENCIL COMPANY INC. NEWARK 4, N.J.

This machine practically thinks for itself!



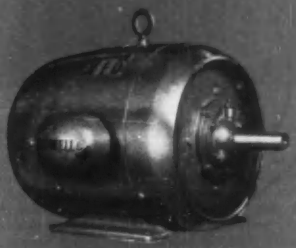
Precision-boring a large fixture —an example of the accuracy and capacity of the Model 4-B DeVlieg JIGMIL.

It's uncanny the way this DeVlieg JIGMIL handles the most complex boring and milling operations *automatically*, simply by pushing a button on the control panel.

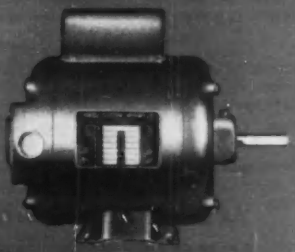
For example — by simple push button control, the workpiece is positioned both horizontally and vertically, and holes are automatically spaced and bored to exact tolerances. A unique index table allows machining of parts from four sides without rechucking. A power tool lock permits locking or releasing cutting tools in a few seconds.

Howell engineers worked closely with this manufacturer to make sure each of the five Howell motors fitted its job exactly. The three 2-speed and two single-speed Howell motors make a vital contribution to the remarkable efficiency of this machine.

Howell will supply the same high degree of engineering skill and experience to your problems. You are assured of quality motors designed for your specific requirements, built to stand up under the heaviest production loads. May we handle your electric motor needs?



HOWELL Type K Motor. Totally enclosed, fan-cooled. Sealed against dust, dirt, fumes and moisture. Sizes from 3 to 100 H.P. at 1200 RPM. For horizontal or vertical mounting.



FRACTIONAL horsepower Howell motors, both single and polyphase, are usually carried in stock. Furnished in standard NEMA frames as either open or totally enclosed types.

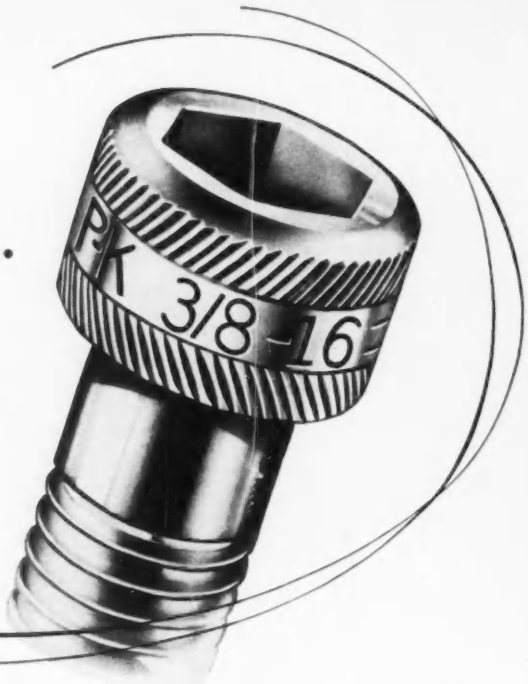
HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built industrial motors since 1915

Here's help for Housewives..



P-K
TRADE MARK
REG. U.S. PAT. OFF.

According to worker supply forecasts, your assembly lines will soon be "manned" by more and more housewives.

Whether housewives or not, any "green hands" on Socket Screw assembly jobs will learn faster and work faster with P-K* Size-Marked Gear Grip Socket Head Cap Screws.

The clearly readable Size-Mark prevents confusion and errors—saves a lot of lost motion. It's a help in the tool crib, too, where left-over, mixed screws can be easily sorted. And the Gear Grip means non-slip starting, speeds the job.

No wonder these time-saving, top quality Socket Screws are wanted, in tremendous quantities, for more of industry's finest products than ever before. P-K production is going 'round-the-clock to meet this mounting demand. For D.O. or other assemblies set your standards by P-K quality. Parker-Kalon Corporation, 200 Varick Street, New York 14, N. Y. Sold through Accredited Distributors.

MORE HELP FOR ASSEMBLY PLANNERS

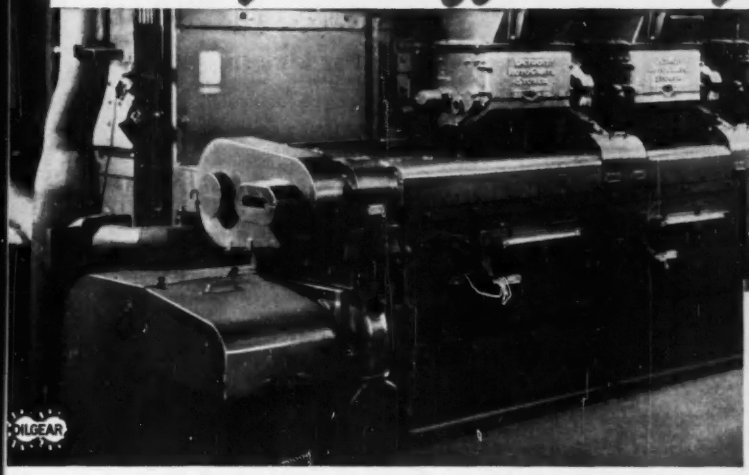
The New P-K Socket Screw Dimension Finder

A pocket-size plastic slide chart gives you all essential dimensions of P-K Socket Cap Screws, Set Screws, Flat Head Screws, Stripper Bolts, and Pipe Plugs. Includes Set Screw Point Dimensions, and Thread Length Formula. Available, FREE from your P-K Distributor.

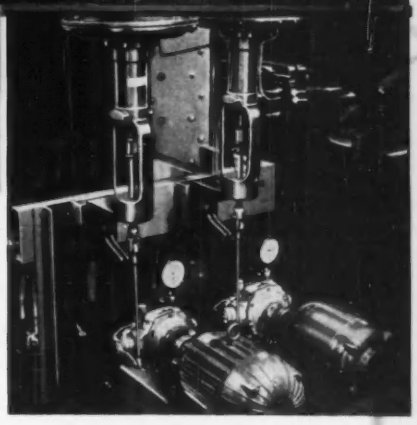
PARKER-KALON*
cold-forged
SOCKET SCREWS

SIZE-MARKED SOCKET HEAD CAP SCREWS • GROUND THREAD SOCKET SET SCREWS
FLAT HEAD SOCKET CAP SCREWS • STRIPPER BOLTS • PIPE PLUGS • HEX KEYS
* TRADE MARKS REG. U.S. PAT. OFF.

"ONE OF THE *Highest Efficiency Units* "IN THE UNITED STATES



View in J. I. Case Co. tractor works at Racine, Wis. Boiler front and Detroit Roto-Grate Stoker on 100,000 lb. per hr. boiler unit.



Two Oilgear Variable Delivery Pumps with simple diaphragm actuated hydraulic servomotor lever controls supply fluid power for the fuel feed and grate drives. An Oilgear drive was experimentally installed on the fuel feed on the first stoker in 1948. On the basis of its performance, Oilgear drives were used for *both* fuel feed and traveling grate on a second stoker unit installed in 1949. Also, Oilgear will replace the mechanical grate drive on the first stoker installed in 1943. Like a shadow, flexible, controllable Oilgear *Fluid* Power causes fuel feed rate and grate speed to accompany steam demand up and down. Recording charts show steam *demand* varies "all over the place," but steam pressure and fuel air ratio stay steady.

And Oilgear's Range and Control help capture savings hidden in J. I. Case 100,000 lb. Boiler Unit

The 100,000 lb. per hour boiler unit in the J. I. Case Co. tractor works at Racine, Wisconsin, has demonstrated that it is one of the highest efficiency units in the United States. To obtain such high efficiency, careful tests of variable speed drives for fuel feed and grate travel were made during two years. Finally, Case engineers selected Oilgear Fluid Power Drives, for, as Mr. Cole H. Morrow, Chief Plant Engineer says, the Oilgear units proved far superior to electric drives and mechanical transmissions under actual operating conditions.

SMOOTH, POSITIVE SPEED VARIATION "In order to obtain high efficiency in any boiler unit," says Mr. Morrow, "*a very precise variable speed fuel feed drive* is required to meet widely varying demand. The Oilgear Drive gives smooth, positive variable speed operation from zero to 100% of capacity with a straight line fuel feed characteristic. This allows us to calibrate the control system for operation within amazingly close limits of fuel-air ratio variation.

EASE OF CONTROL "Also, on this type of stoker the grate speed must be infinitely variable from minimum to maximum yet maintained in direct proportion to the rate of fuel feed. Every change in fuel feed requires an immediate and directly proportionate change in grate speed. (Such synchronization) is easily obtained with the Oilgear drive units because of their ease of control, and the simplicity and low force requirements of the control mechanism."

UNLIMITED SPEED RANGE Also, fuel feed and grate drives must have a range of speed at least equal to the demand range. Most drives have a range not exceeding 4 to one. Yet at Racine, during the summer, demand drops far below the 25,000 lb. threshold imposed by such a ratio. The Oilgear Drives however have no "ratio" limits, would function down to zero load if necessary. In fact, they give precise load control down to a load of 15,000 pounds per hour normally obtained each day during the summer, and down to as low as 5,000 pph over the weekends still under full automatic control.

OUTSTANDING RELIABILITY "One of the outstanding features we discovered . . . was the *reliability of the Oilgear units*. The experimental installation operated almost continuously for a year and a half without any difficulty. This record was far better than we were able to obtain with any other type of drive or transmission."

These four features, variability, ease of synchronization and control, actual range from zero fpm, rpm or torque up to maximum, and reliability proven over and over again, are indications of the many advantages Oilgear drives and transmissions offer in machine design and use. Investigate Oilgear equipment as a *better* solution for your problems. THE OILGEAR COMPANY, 1571 West Pierce Street, Milwaukee 4, Wisconsin.

Oilgear

PIONEERS IN FLUID POWER
PUMPS, TRANSMISSIONS, CYLINDERS AND VALVES

Behind your television screen...

Rubber Television Anode Shield Manufactured by Continental for the Ucinite Company

Continental Rubber gets into the act

In the unseen act behind your television screen, a small cup-shaped rubber shield plays an important role. This shield fits over the anode on the side of the tube. Its function is to "seal in" high voltage current and thus prevent surface discharges that cause picture distortion.

Ordinary rubber compounds, of course, can't fill the bill. *This* rubber part must have exceptional dielectric properties and unusual stability under sustained heat. It must resist the deteriorating effects of ozone created by electrical discharges. In addition, the rubber shield must be precision molded to insure proper seating against the side of the television tube.

Continental engineers, working closely with Ucinite Company engineers, have met these exacting requirements. This technical cooperation typifies the service in rubber offered by Continental.

When *you* need better engineered rubber parts, why not enlist the service of specialists in molded and extruded rubber?

LET US SEND YOU THIS CATALOG

This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

See our Catalog in Sweet's File for Product Designers

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DUNCAN & BAYLEY, INC.

POSITION SERVO ACTUATORS

ZERO BACKLASH for LIFE...

independent of extreme precision

Zero backlash is achieved in Duncan & Bayley Position Servo Actuators by virtue of design rather than high cost fabrication. No springs, no close tolerances on gear centers, no split gears are employed. Reduced shock loading eliminates excessive tooth wear. In addition, Duncan & Bayley Position Servo Actuators incorporate these PLUS advantages.

- Function independent of ambient temperature beyond most airborne requirements.
- Eliminates motor armature inertia; effective torque to inertia ratio improvement 20:1. Torque is independent of speed.
- Torque repeatable for equal conditions within ±1% independent of speed.
- Improved amplification factor, output 80 watts for 40 MA (3 watt) control.
- Continuous heat dissipation 40% of maximum rating.
- Life consistent with typical industrial machinery.

Applications for Duncan & Bayley Position Servo Actuators

Radar antennae transmissions

Autopilots

Computer Drives

Valve Servos

Tension Controls

MANUFACTURED BY

DUNCAN & BAYLEY

DIVISION OF GENERAL RIVETERS, INC.

785 Hertel Avenue • Buffalo 7, N. Y.

EVERY **SEALMASTER** BEARING

Pre-Lubricated

FOR A LONG STRETCH OF SERVICE

1. PERMANENTLY SEALED
Felt-lined steel flinger, rotating in labyrinth, excludes dirt and retains proper amount of lubricant.

2. SELF-ALIGNING
Bearing unit, with seals independent of housing, can align itself in any direction without seal distortion.

3. PRE-LUBRICATED
Before shipment from the SealMaster factory, the bearing chamber is filled with proper amount of lubricant.

4. NO HOUSING WEAR
Patented locking pin and dimple prevent rotation of outer race in housing. This eliminates housing wear, permits shaft alignment and positions unit for relubrication.

5. FLOATING RETAINER
Ball retainer is designed to float on ground inner surface of outer race. Traps lubricant, prevents churning.

6. HOUSING DESIGN
SealMaster's cast housings combine rigid, one-piece construction with smooth streamlined appearance.

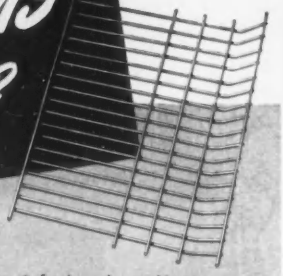
Bearing maintenance at low cost is a feature worth designing into your machines. In SEALMASTERS the lubricant is sealed-in at the factory. Thus, SEALMASTER Ball Bearing Units assure smooth operation, and long life—with reduced power consumption.

Ask for Catalog 845—for complete data on SEALMASTER *Bearings.*

SEALMASTER BEARINGS
9 RIDGEWAY AVENUE, AURORA, ILLINOIS
A DIVISION OF STEPHENS-ADAMSON MFG. CO.

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

Any of these PROBLEMS Like Yours?



Had to Conserve Steel

Ice deflector assembly made by Company A for ice cube machines consisted of sheet steel, woven wire cloth and steel frame. Material shortages loomed. Told it to Titchener. Titchener designed this welded wire rack using one size of wire. New assembly proved to be sturdier — rustless — lower in cost. Additional dividends: simple tooling — fast large-scale production.

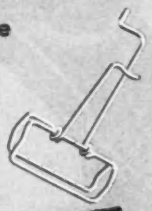
Note: Wire is more readily available during shortages. Can your product be made of wire? Ask Titchener.

Wanted Substitute for Casting

Company B, a stove manufacturer, was dissatisfied with breakage of its cast iron burner grates. Told it to Titchener. This Titchener welded-wire assembly was substituted. Result: No breakage — costs less.

Note: Wire is rigid, yet resilient. Light, yet tough. Stronger than castings or forgings. Wondering if wire can help you? Ask Titchener.

Design Was Difficult to Produce



Company C designed this complicated two-piece floor mop wire clamp. Ran into production difficulties. Told it to Titchener. Our skilled tool makers developed an ingenious method of coiling wire around itself. This made it possible to produce thousands of precision-made clamps at high speed on Titchener's forming machines.

Note: Titchener has worked hand in glove with all types of industry — large and small — in peace and war — for 45 years. How can Titchener serve you?

Tell it to TITCHENER!

If your problem involves wire forms, light stampings, welded-wire assemblies or wire-and-strip-steel items — Tell it to Titchener.

Titchener offers you . . .

- Design Assistance
- Tool and Jig Making
- High Volume Production
- Plating and Finishing
- Sample Making
- Quickly Available Materials
- Careful Inspection
- Prompt Delivery

Send us your prints — or describe your problem in a letter. Confidential. No charge for our suggestions.

E. H. TITCHENER & CO.
103 CLINTON ST. BINGHAMTON, N.Y.

"... as inevitable as death and taxes"

sooner or later you will switch to MOLYBDENUM High Speed Steels

It is inevitable, and fortunately, it is easy, so why not change now? This has been going on, on a merit basis, for years.

Our booklet (below) gives you all the practical facts you need to make the switch. You can save money; you will help the national effort by conserving tungsten for uses in which it is really needed. Above all, you will get a tool which is every bit as good as a tungsten type—many people think better!

All the facts you need in this FREE BOOKLET

Climax Molybdenum Company
500 Fifth Avenue · New York City

Please send your FREE BOOKLET
"MOLYBDENUM HIGH SPEED STEELS"

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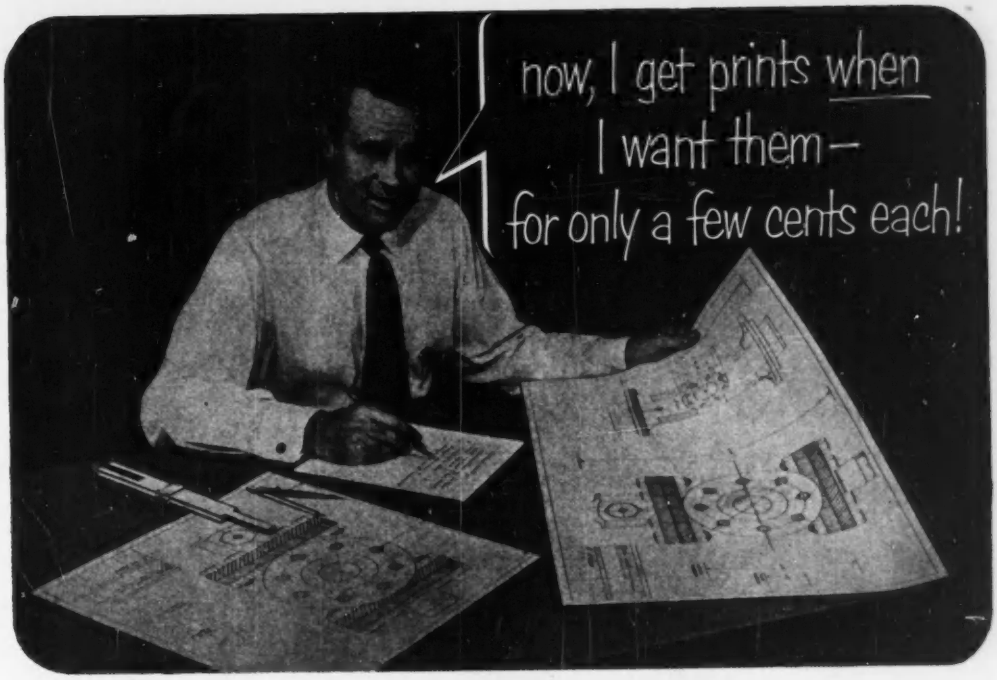


NEW! the low-cost* COPYFLEX "20"

With this new, low-cost whiteprinter, the Copyflex "20", you no longer need wait for prints. You get them *when* you want them, *as* you want them—for only 2¢ (average) per. sq. ft.! And that includes *all* costs . . . material, labor, depreciation, etc.

The Model 20 is a completely new, medium volume machine that sells for the lowest price of any machine in its class. It has a full 46" printing width, takes cut or roll stock, and delivers completely developed, ready-to-use prints. It requires no installation, no special training to operate.

Besides making prints of your engineering drawings, it quickly copies production orders, specifications, accounting reports, and other vitally needed paperwork. See how the Model 20, or one of our other models, can help you. Clip the coupon now and you'll be on the road to faster copying—at substantial savings.

Compare these advantages:

- *LOWEST PRICED machine of its class available.
- NO FUMES. Bruning Copyflex machines use no vapor developer, therefore cannot possibly emit unpleasant fumes.
- NO INSTALLATION. No exhausts needed. Just connect to a 115 volt AC electric power circuit.
- NO TRAINED OPERATOR NEEDED. Your secretary, the office boy, or anyone else can operate a Copyflex without special training.

BRUNING

Specialists in copying since 1897

CHARLES BRUNING COMPANY, INC.

Dept. V-121 100 Reade St. New York 13, N. Y.

☐ Send me full details on the Model 20 Copyflex.

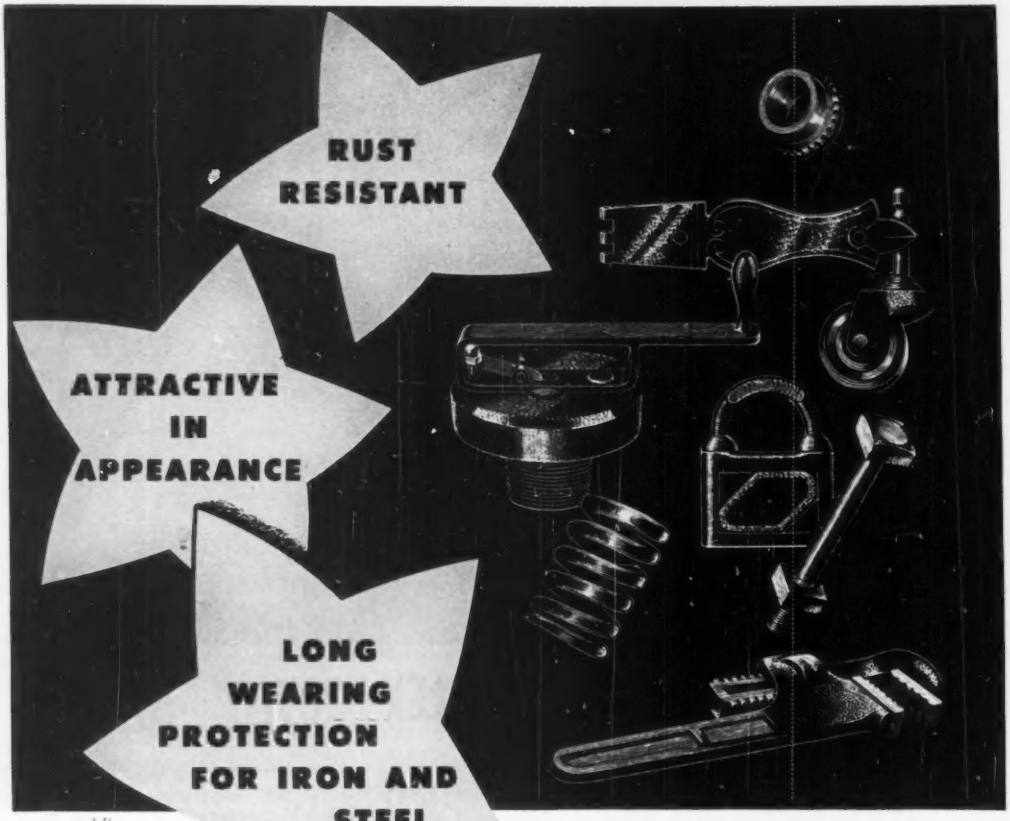
☐ I would like to see a Copyflex machine demonstrated.

Name_____ Title_____

Company_____

Street_____

City_____ Zone____ State_____



— PARCO COMPOUND

Parco Compound, constantly improved over the past third of a century, now offers greatest efficiency and economy in the protection of iron and steel against rust and corrosion.

In addition to rust resistance, Parco Compound adds greatly to the attractive appearance of the treated parts. When it is combined with stains or oils, a very dark satin finish is produced. Treated metal may be waxed, or may be painted with excellent results.

While efficiency and flexibility has increased, cost is still extremely low. Treatment with Parco Compound is quick, simple, uniform, completely dependable. The only limitation on size of parts treated is the size of the processing tanks.

Parco Compound meets government specifications for military use, and is replacing cadmium and zinc in many civilian applications.

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

PARKER

PARKER RUST PROOF COMPANY
E. Milwaukee Ave.
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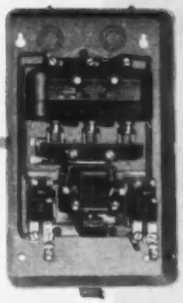
CORBERITE—corrosion resistant paint base • **BONDERITE** and **BONDERLUBE**—aids in cold forming of metals • **PARCO COMPOUND**—rust resistant • **PARCO LUBRITE**—wear resistant for friction surfaces

The sensational New CLARK TYPE "CY" AC MOTOR STARTER

available in a wide variety of types and enclosures

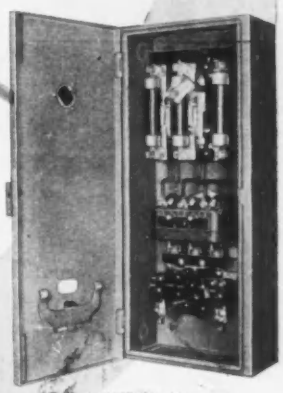
The superior performance, lower maintenance and longer life of the new CLARK Type "CY" can now be applied to almost any machine or operation requiring AC motor starting. A few of the many adaptations are shown here.



Bulletin 6013 CY2 Non-reversing across-the-line starter.

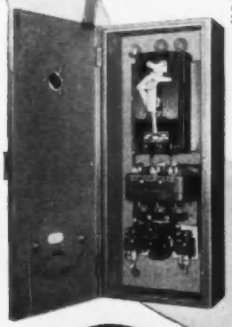
The new CLARK Type "CY" provides the extra protection and dependable operation of "Mill-Type" heavy-duty construction and design. The combined use of strong multi-turn magnetic blow-outs and twin-break contacts results in new standards of starter dependability and long, trouble-free service. Constant forced rotation of the arc prevents burning or pitting of contacts—a big factor in reducing starter maintenance. The ingenious design of the arc chamber prevents formation of carbon and accumulation of ionized gases between wiring terminals — minimizing phase-to-phase failures.

For every A.C. motor-starting application, the new CLARK Type "CY" means increased production and less maintenance.

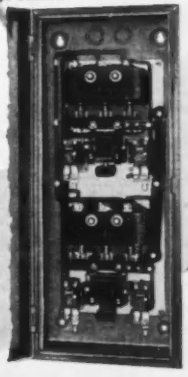


Bulletin 6018 CY2 Combination Starter with fusible safety switch, in Safe-Edge Cabinet.

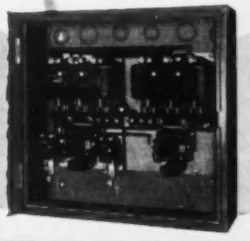
Bulletin 6020 CY2 Starter with air circuit breaker, in Safe-Edge Cabinet



Bulletin 6050 CY2 Two-speed single winding Consequent-pole starter — in Safe-Edge Cabinet.



Bulletin 6030 CY2 Two-phase, 4-wire, 4-pole reversing starter — in Safe-Edge Cabinet.



Let a CLARK application engineer demonstrate the many advantages of the new Type "CY" line of AC Magnetic Starters.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1142 EAST 152ND STREET, CLEVELAND 10, OHIO

HEAT needn't cool off ideas for better products

HOT POPCORN DISPENSER BASE
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AUTOMATIC VAPORIZER
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. . . just ask your molder about DUREZ phenolics

● Where heat conditions are involved, first thoughts on plastics in product planning sessions are naturally concentrated on the phenolics. These alone of all plastics are generally heat-stable up to 300°F., and in heat-resistant grades up to 400°F. and higher.

As specialists in developing phenolics to meet unusual as well as common requirements, Durez has carried heat resistance well beyond the limits of recent years. Recurrent temperatures in the area of 500°F. are being met by mineral-filled Durez compounds with no loss of dimensional stability, strength, luster and other desired properties.

The Durez in the vaporizer illustrated is impervious to mild solvents, hot or cold. The 15″x 12″x 5″ popcorn warmer base is warp-free. The iron handle never burns the ironer's hand. The soldering tool is safe and comfortable to use.

Whatever the product, your custom molder can help you see how heat resistance and other unusual properties of Durez can be used to advantage—in time and money.

Our field engineers are always ready with technical assistance.

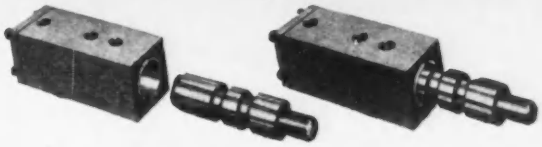
Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead, to Durez Plastics & Chemicals, Inc., 2012 Walck Road, North Tonawanda, N. Y.

PHENOLIC PLASTICS **THAT FIT THE JOB**

PERFECT PINS + PERFECT HOLES = PERFECT FITS

SUNNEN EXTERNAL HONES For Outside Surfaces and SUNNEN HONING MACHINES for the Holes—

Four external hone sets handle complete range from .120" to 2.750"



It's the New Way to Get Exact Fits Without Lapping

Now, with Sunnen *External* Hones you can match the precise accuracy and exceptionally smooth surface finish produced by Sunnen Internal Honing. These new hones *for outside surfaces* are ideal for finishing parts such as valve pistons, pins, arbors, plungers, ejector pins, spindles and shafts. Diameter range is from .120" to 2.750".

Sunnen External Hones are the *only* external hones with extension holders designed for removing heat treat warpage. Defects such as waviness, warpage, out-of-round, and centerless grind patterns are corrected quickly and with minimum stock removal. Accuracy is guaranteed to within .0001"—can be held to a few millionths on some jobs.

TYPICAL APPLICATIONS

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SP-640

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☐ Please send bulletin on external honing. ☐ Have representative call.

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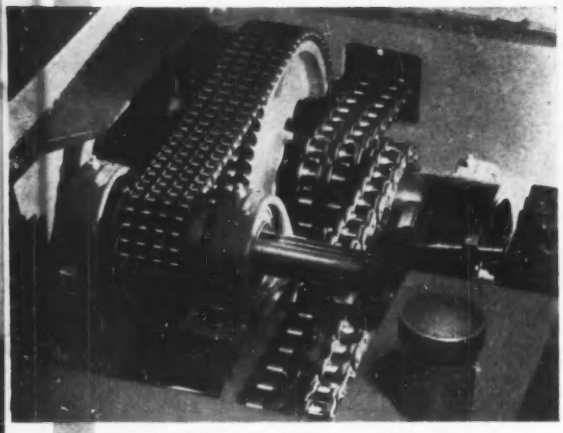
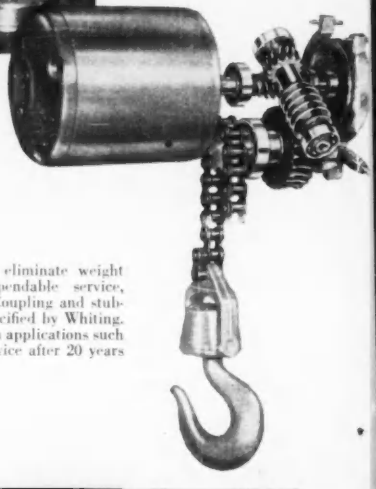
ONE sure, low-cost answer transmission

SECRET of the Trackmobile's pulling power is an in-built hydraulic jack. After car is coupled, the hydraulic jack raises the coupler sufficiently to transfer part of the car's weight to the Trackmobile, thus giving the Trackmobile enormous tractive effort. Precision-engineered and precision-built Morse Roller Chains then deliver the tremendous power to move the heavily loaded Trackmobile with ease.

SMALL BUT POWERFUL Whiting Electric Hoist uses Morse Roller Chain over extra-large Morse Sprocket for maximum strength, minimum wear. Chain won't stretch, bind, twist . . . assures longest service life.



QUADRUPLE-, double-, and single-strand Morse Roller Chain in Trackmobile's main drive assure positive, no-slip power. Dependable Morse Roller Chains operate equally well on long or short centers . . . absorb great shock and strain. Chain prelubricated and packaged to specifications.



TO SAVE SPACE, eliminate weight and give really dependable service, Morse Roller Chain, Coupling and stub-shaft assembly are specified by Whiting. Morse Roller Chains in applications such as this are still in service after 20 years of use.

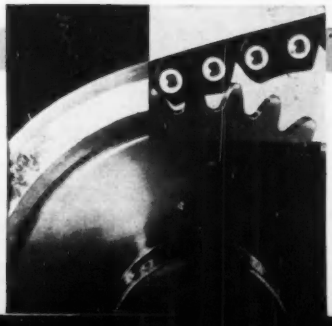
Ask the Morse Man for power transmission information!

100 Morse Branch Offices and Distributors to supply your power transmission demands.

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under **"Power Transmission"** or **"Chains"** for the nearest Morse Man.

Morse

Drive



to TWO tough power problems . . . . MORSE!

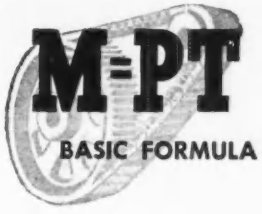
When ordinary power transmissions couldn't fill the high-power requirements of the Whiting Trackmobile, Whiting turned to Morse.

They got the answer, quick! Morse Roller Chains and Sprockets, a Morflex Coupling and Roller Chain Couplings now transmit more than enough power for the Trackmobile to spot, switch and haul fully loaded railway cars with ease . . . at less operational cost, too!

Morse answered another Whiting demand, too, by furnishing roller chain and sprocket stub-shaft assembly, small and sufficiently light in weight to fit the compact, exacting design of the Whiting Electric Hoist . . . yet sturdy enough to lift heavy shop materials.

Two *more* tough power transmission problems whipped by Morse!

If you have a tough problem in power transmission, get in touch with Morse. Morse has a complete line of superior roller and silent chain drives, couplings and clutches, including the sensational new HY-VO Drive. And Morse engineers are unusually expert at helping you utilize them for more efficient, trouble-free power transmission at a savings.



Morse *means* Power Transmission

Revolutionary Morse HY-VO Drive transmits more horsepower at higher speeds than any other type of drive

A single HY-VO Drive will transmit up to 5000 H.P., with up to one-third longer service life. New design principles practically eliminate pounding, bouncing, jerking, vibration. HY-VO opens way to transmit more horsepower from smaller, less costly high-speed engines. We welcome your request for more information (at present time, though, *orders* must carry priority rating).

MORSE

MECHANICAL *POWER TRANSMISSION* PRODUCTS

PRODUCTS OF BW BORG-WARNER

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Duplicating Machine Housing, molded by Gregstrom Corp., Cambridge, Mass., for Standard Duplicating Machine Co., Boston, Mass.

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Check over these Boltaron features: resists impact, abrasion, alkalis, acids, staining; is water-proof, mildew-proof, vermin-proof, grease-proof. It can be punched, drilled, tapped, bolted, riveted, sawed, sheared, cemented, sewed, sanded, printed, hot-stamped, cleaned, waxed; available in a range of decorative colors, finishes, grains.

SOME OF THE HUNDREDS OF USES OF BOLTARON

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Boltaron

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A NOVEL and UNIQUE CIRCUIT INDICATOR

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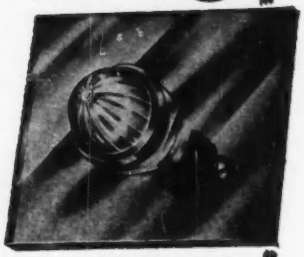
For 110 or 220 volt circuits
The required resistor is an integral part of this assembly —"built-in."
RUGGED DEPENDABLE LOW IN COST



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UNBRAKO
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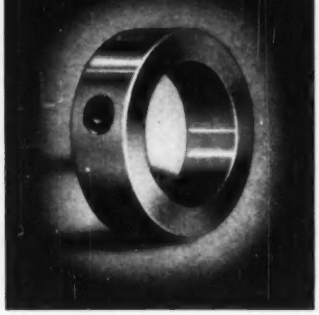

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Two parts are handled as one, even in flat or oval head screw applications.

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Let a Shakeproof engineer study your product to see if improved fastening methods can reduce your costs. Write for details, today!

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SHAKEPROOF POWER SCREW DRIVER

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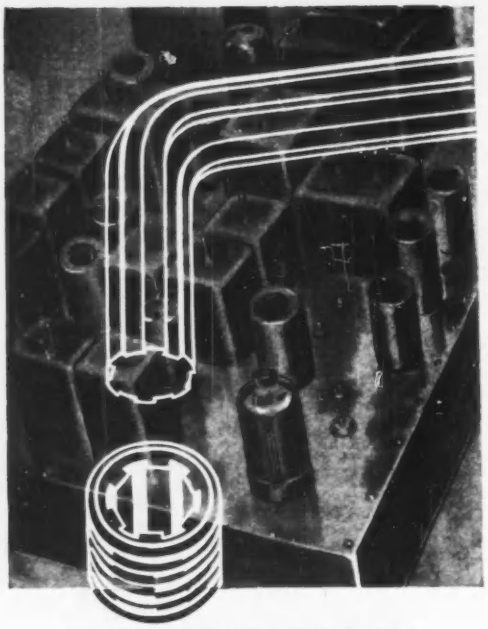

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They *hold* tighter . . . because they can be *tightened* tighter.

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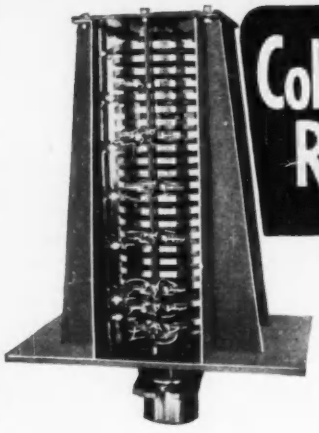

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...rated at
2500 POUNDS
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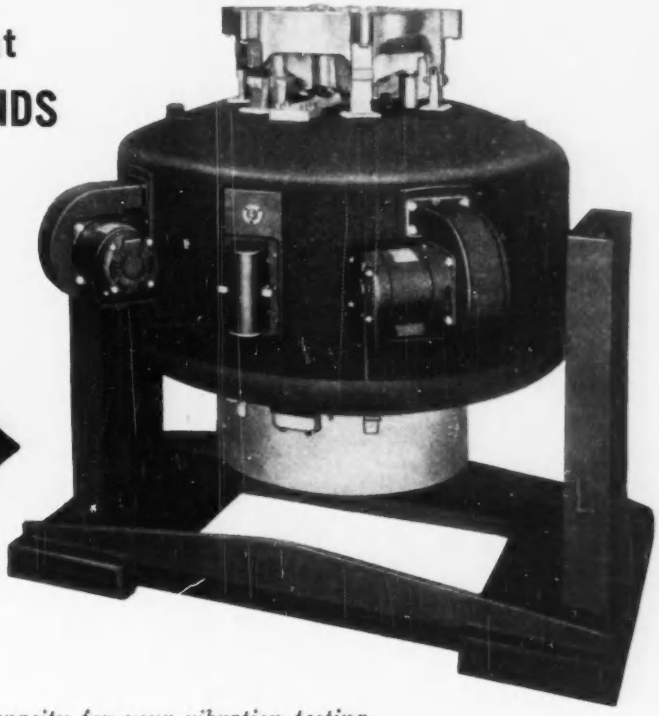

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15g at 100 lb table load!
Electrically interlocked control!
No foundation needed!

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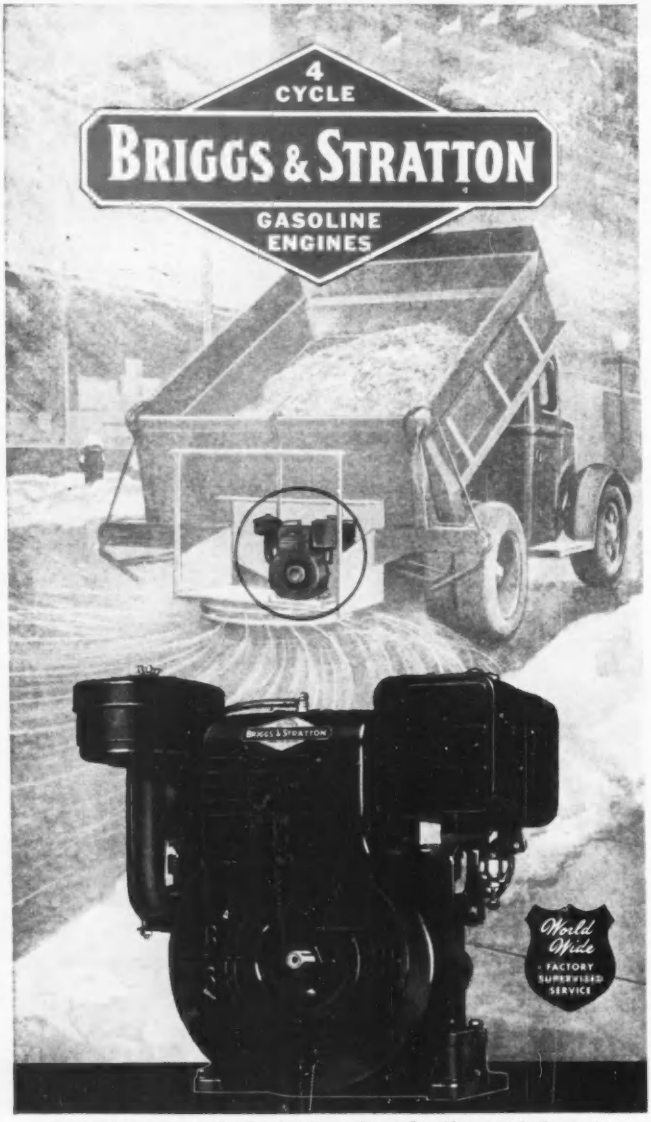

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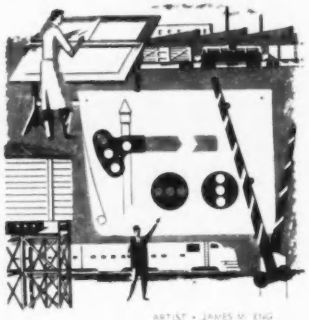

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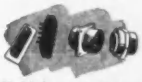
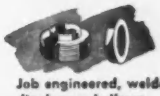


Multiple contact connectors to meet government specifications.



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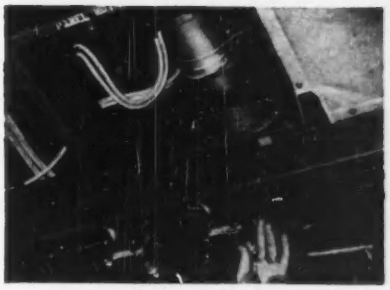

Breeze rotary actuator releases twenty 500 lb. paratainers from Fairchild Packet in 10 seconds.

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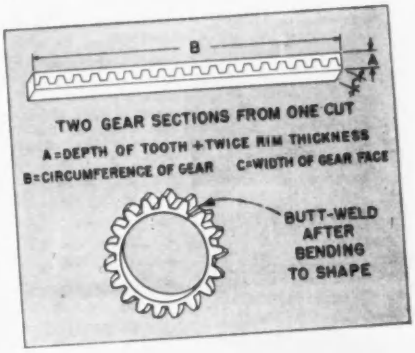
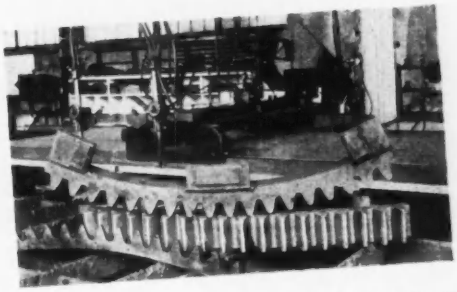
Careful consideration of allowable tolerances often results in reduced costs through elimination of overdesigned parts. Precision gears, for example, are an unwarranted expense where more economical gears that are accurate within 1/64 inch will give just as satisfactory service.


B
A
TWO GEAR SECTIONS FROM ONE CUT
A=DEPTH OF TOOTH +TWICE RIM THICKNESS
B=CIRCUMFERENCE OF GEAR C=WIDTH OF GEAR FACE
BUTT-WELD AFTER BENDING TO SHAPE

Such gears, for farm machinery, cement mixers, and similar equipment are produced by oxygen-cutting and welding as shown in the sketch. One cut makes two gear sections. There is no scrap loss. Welded circular sections require further finishing only in weld areas.



Eight steel sections like this, oxygen-cut from 5-in. thick slabs, are welded together to make 14-ft. diameter gears for pontoon cranes. Maximum tolerance is only 1/32 in., but no machining is required.

For further information about oxygen-cutting, welding and other cost reducing LINDE methods, phone or write LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N.Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

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Electrical ratings at 125/250 V AC between 1200 watts and pilot duty depending on differential. The Vacuum Switches offer adjustable ranges from 30"-0" hg vac with adjustable on-off differential from .1" wc-10" wc. Furnished as calibrated micrometer type or uncalibrated with screw driver adjustment. Electrical ratings of both models 1200 watts at 125/250 V AC.

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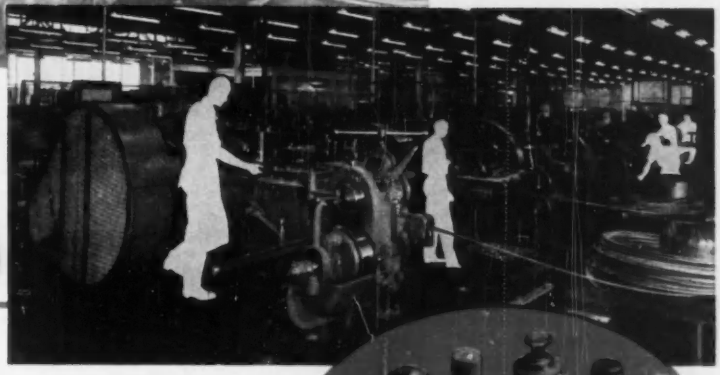
the Skill



the Facilities

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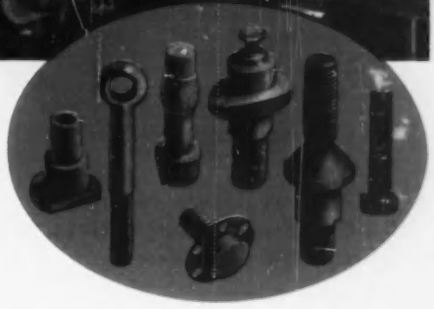

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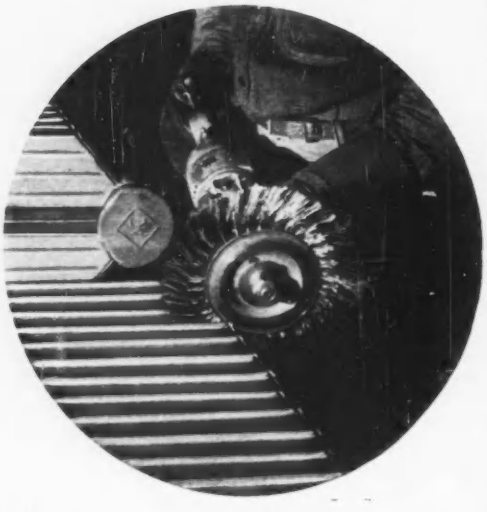
How a Pittsburgh Brush Solved an Oil Pressure Problem*



* **An actual case history from the Allis-Chalmers Pittsburgh Works, manufacturers of transformers.**

At Allis-Chalmers, well-known manufacturer of industrial equipment, the problem was to secure a satisfactory oil pressure test on transformer radiators. The key to the problem was to find a brush narrow enough to clean between cooling fins and strong enough to remove slag and spall on welds which could conceal pinholes. Pittsburgh engineers recommended an 8" rotary wire brush. The brush proved more than satisfactory and the problem was solved!

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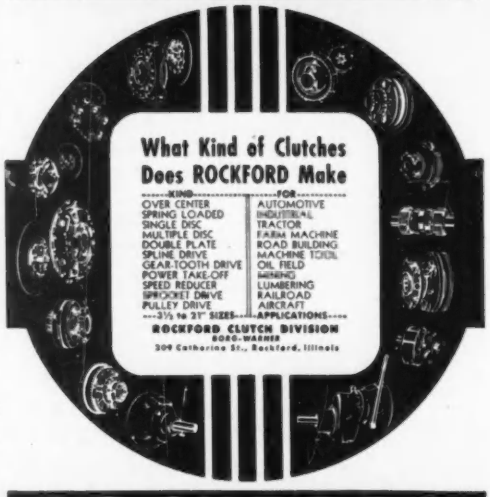
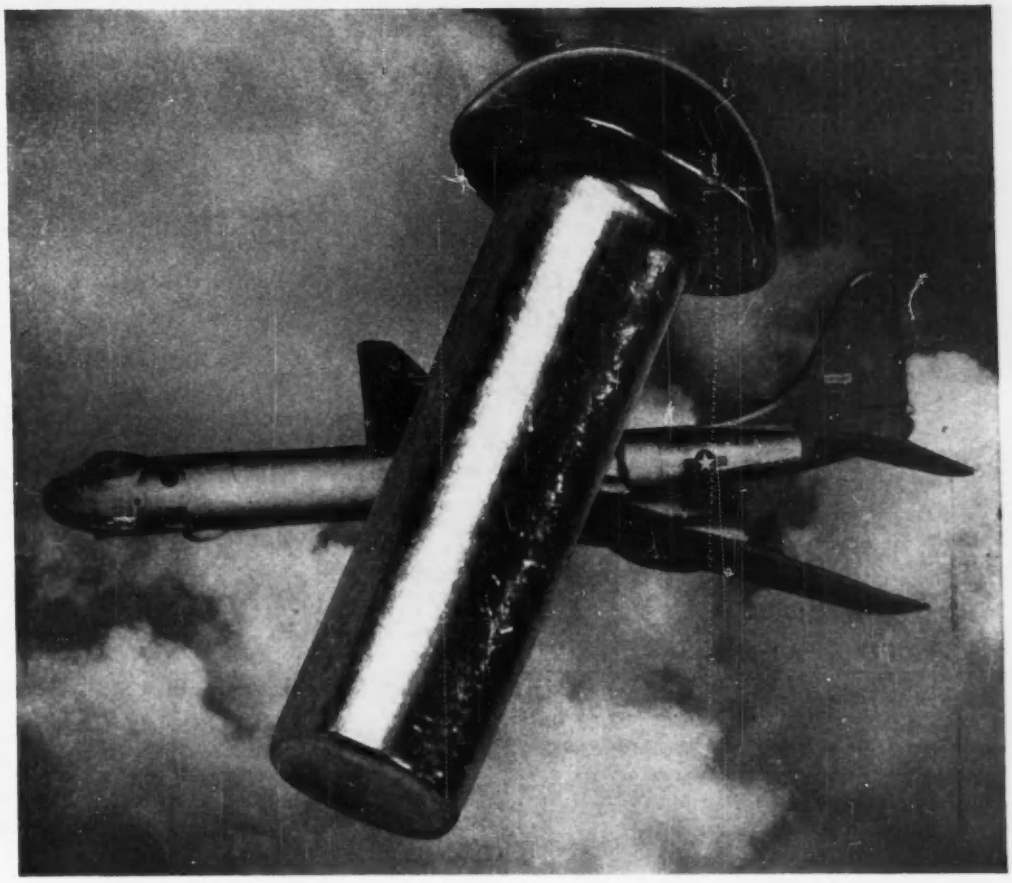


ROCKFORD CLUTCHES



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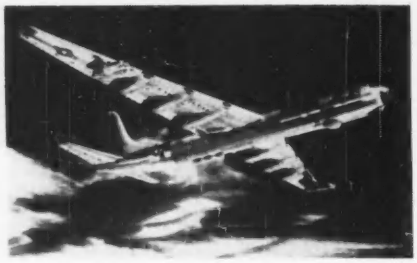

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New Hampshire MICRO Ball Bearings, Inc.

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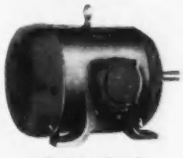

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The properly selected protection with the wide variation of starting torque characteristics to choose from provides long operating life and improves the production of the driven equipment.

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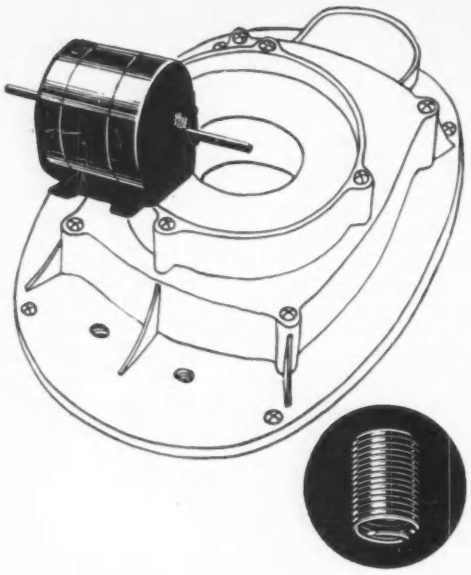

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With Heli-Coil Inserts, clumsy and costly solid bushings are eliminated . . . design is simpler and product improved. The Heli-Coil system permits fewer bolts and shorter threads . . . permits production salvage of damaged parts previously unusable.

Heli-Coil Inserts fit National Coarse and Fine Threads, pipe threads, automotive and aviation spark plug threads. Meet all aircraft, industrial and military specifications for Class 2, 2B or 3 fit.

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CARBON AND STAINLESS STEEL
CAST TO MICROMETER TOLERANCES

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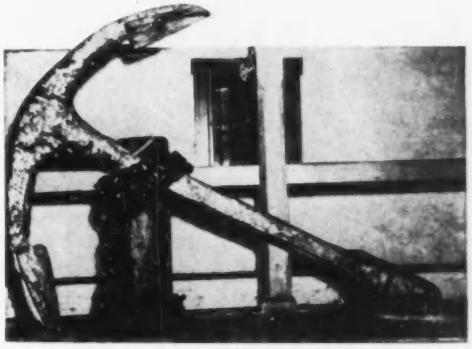
Corrosion of Bearings-1

ALL bearing materials should be fabricated to meet requirements of corrosion resistance. These requirements are of two distinct types. Corrosion resistance prior to installation and corrosion resistance after installation.

Prior to installation, bearings may corrode during shipment or in storage. The corroding medium usually is water or water vapor due to occasional exposure to high humidity or actual condensation of water where cold metal is brought into a warm room under such conditions that the temperature of the metal is below the dew point. In some rare cases corrosion may be caused by certain gases present in the atmosphere. These instances should be given individual study in order to arrive at the proper preventive. The resistance of the bearing metals to corrosion due to water or prior to installation is of a different order than corrosion resistance under operating conditions. In this first treatise we will limit the discussion to the former.

The approximate tendency to corrode in the presence of water is shown in figure No. 1, under room temperature conditions. Steel is the most sensitive of all the materials used and precautions have to be taken to protect the steel against rusting. The amount of protection required depends on the expected time of exposure to atmospheric conditions. If steel-backed bearings are to be placed in service shortly after manufacture, then a light film of oil will suffice. For periods of protection up to six months an electro-deposit of tin or a heavier oil coating is used. For periods of protection up to two years an electro-deposit of tin, plus a light grease is used. For longer periods or for overseas shipment a heavy grease is often used.



An excellent example of resistance to corrosion is this old bronze anchor recently dredged up from Monterey Bay, California, where it had lain in salt water for over 300 years

A protective oil is required for lead-base babbitt for storage periods longer than six months.

Both steel and lead-base babbitt are characterized by pitting when corrosion due to water vapor takes place. A few pits will not harm either of these materials but extensive corrosion may result in undesirable dimensional changes.

Copper-lead will corrode because the lead phase is exposed but the lead is isolated in small areas and not subject to the more extensive attack of lead-base babbitt.

Tin base babbitt, bronze and aluminum may stain on exposure to the atmosphere but damage due to corrosion under these conditions is practically unknown.

The corrosion of bearings under service conditions is due to entirely different factors than under storage conditions.

Service conditions are discussed in data sheet . . . Corrosion-2.

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

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This bearing sheet data is but one of a series. You can get the complete set by writing to—

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Relative Comparison of Corrosion

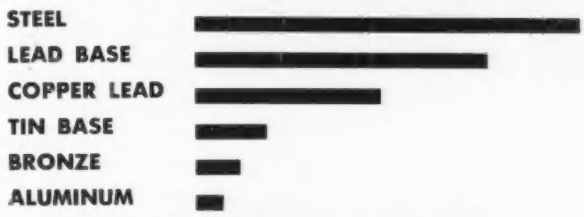
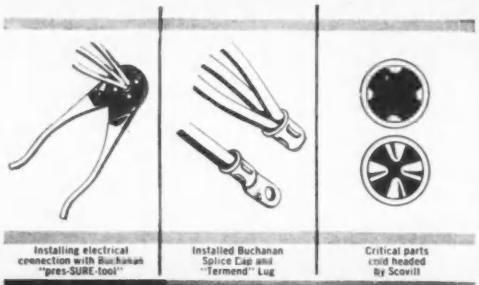
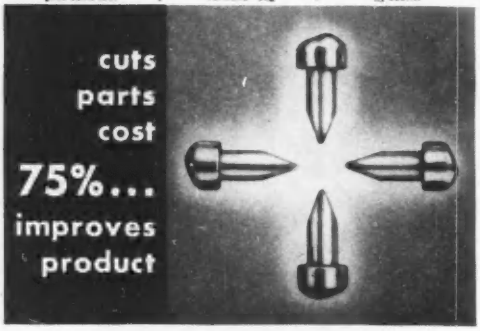


Fig. 1 Tendency of bearing material to corrode in the presence of water vapor at room temperature.


Installing electrical connection with Buchanan "pres-SURE-tool"
Installed Buchanan Splice Cap and "Termend" Lug
Critical parts cold headed By Scovill



with SCOVILL cold heading

This special crimping tool, manufactured by Buchanan Electrical Products Corp., makes electrical splices and terminations, quickly and easily. The wedge-shaped parts which do the actual crimping formerly required four different manufacturing operations. Now they are cold headed by Scovill at about one-fourth their previous cost.

Perhaps Scovill cold heading can help short-cut your way to lower production costs, in a new product you now have on the board, or one up for re-design. Your sample, blueprint or outline of your problem will get prompt attention from Scovill's cold heading design experts.

"Guide to the Profitable Use of Cold Heading"—Bulletin No. 2 describes the advantages and limitations of this process for the designer. It's free for the asking.

RECESSED HEAD SCREWS • SEMS • TAPPING SCREWS
STANDARD MACHINE SCREWS • SPECIAL COLD HEADED PARTS

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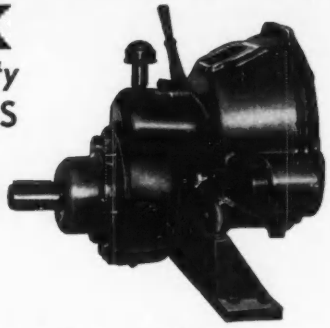
FUNK *Heavy-Duty* CLUTCHES *and* POWER UNIT DRIVES



FUNK Power Take-Offs are available in a wide variety of types to fit most requirements for shaft speed and installation space. Designed to fit any Ford Industrial Engine or standard SAE flywheel housing. *Above* is heavy duty clutch and gear reduction unit. Write for specifications, or for assistance on any special power problem.

FUNK Products include:

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- Gear reduction take-offs
- Right angle take-offs
- Front end take-offs
- Jack shaft extensions
- Ford Tractor Conversion Kit changes to 6 or V-8 engine, doubles power.

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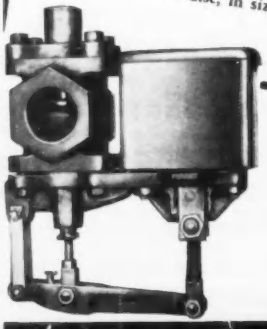
You *can* get a solenoid valve that operates under differential pressures up to 150 lbs., temperatures to 400°F., *without pilot valves*. It ends the time lag and wiredrawing that come with slow opening —the danger of sticking that comes with auxiliary pistons. It offers unusual possibilities for all types of automatic, or remote, flow control. Johnson Solenoid Valves are available for normally closed or normally open service; with stainless steel valve and seat or Jenkins disc; in sizes from ½" to 3".

Write for Bulletin "V"



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- Temperatures to 400°F.
- Differential Pressures to 150 lbs.
- Immediate full flow
- Heavy duty construction

The Johnson Corporation

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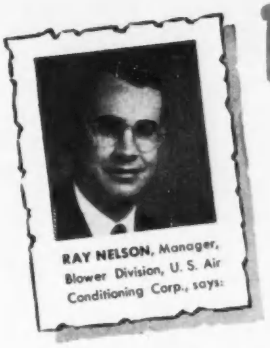


RAY NELSON, Manager, Blower Division, U. S. Air Conditioning Corp., says:

Durkee-Atwood V-Belts solved our Vibration problem

"In designing our Type CH Ventilating Sets, we found heavy vibration in test models . . . and traced the trouble to the short-center V-drive. When we called in Durkee-Atwood engineers, they showed us that the vibration was caused by the multiple belts. Durkee-Atwood solved this problem by vibration-testing their standard belts on their special equipment to meet our requirements. These belts, perfectly matched and with uniform cross sections, completely eliminated vibration. They run so true that *we have not had a single complaint from the field* on the performance of this ventilating set."

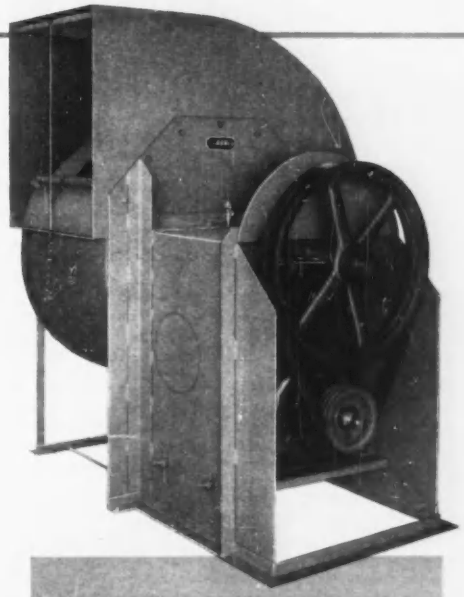
WHAT'S *YOUR* V-BELT DESIGN PROBLEM?

Vibration? A "different" V-drive? Then give Durkee-Atwood a chance to help engineer the design! Durkee-Atwood is a medium-sized company, so we can give exacting attention to every belt order. With our special testing equipment, we assure absolute matching of multiple belts . . . make sure that cross sections are perfectly uniform. This means *vibration-free* transmission for you . . . smoother operation and longer lasting service for your products.

Our moderate size permits fluid production, too—special work and emergency orders. Yet D-A's six modern plants and up-to-date equipment can handle your biggest orders!

If your current project calls for a unique V-drive—a "mule drive" for example, or a drive using sheaves smaller than recommended minimums—experienced Durkee-Atwood engineers are at your service. They will help you meet your special OEM requirements . . . help you get the results you want.

In our 30 years in business, we have established a record for quality V-belts. That is why we can *guarantee* the life of every Durkee-Atwood V-Belt! Write for complete details—or ask your nearest Durkee-Atwood distributor.



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V-DRIVE ENGINEERING DATA—
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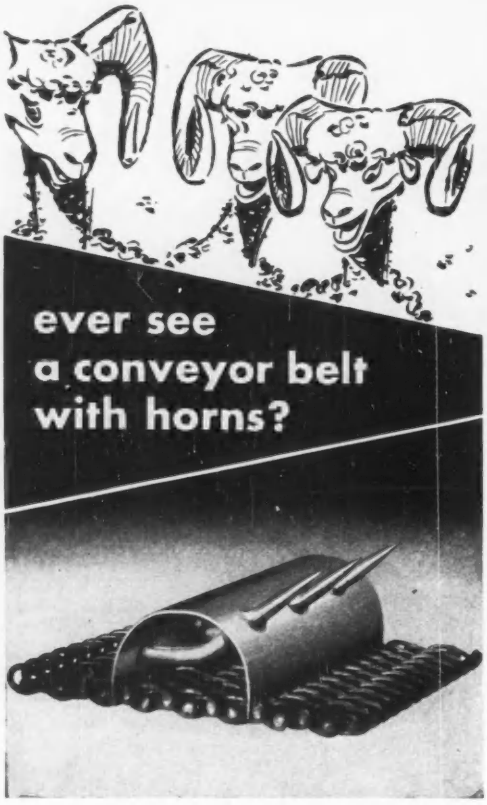
DURKEE ATWOOD V-BELTS

Form No. 522

DURKEE-ATWOOD COMPANY
Dept. PE-12 • Minneapolis 13, Minnesota



Textile processors will recognize this unique belt as part of a Bale Breaker . . . the device that rips apart bales of raw fibre for processing. Heretofore, it has consisted of a series of steel spikes mounted on canvas belting. However, the spikes often strike stones, bits of metal or other foreign objects inside the bale, causing sparks that ignite flash fires that burn the belt itself.

Cambridge design engineers solved this problem by attaching metal spikes to a standard *woven wire* conveyor belt. Results: fewer fires because Monel metal spikes reduce sparking, no belt damage or repairs when fires do occur, water from sprinklers will not harm the belt, longer belt life from all-metal construction.

This is a typical example of the many unusual or difficult problems solved by the use of Cambridge woven wire conveyor belts. Cambridge belts can be constructed from any metal or alloy in a wide range of open or closed weaves. For any problem of combining product movement with processing through heat, cold or corrosive agents, rely on the experienced advice of your Cambridge Field Engineer. Write direct or see "Belting-Mechanical" in your Classified Telephone Directory.

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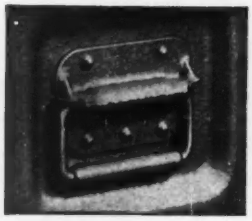

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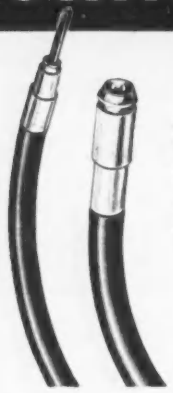

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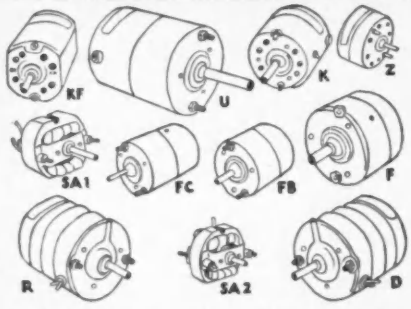

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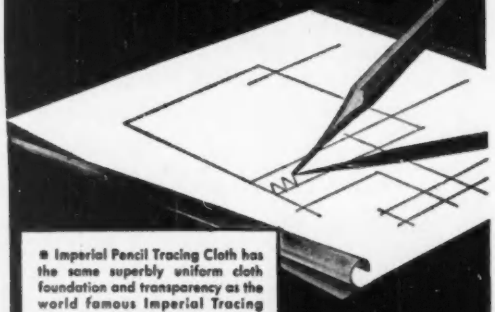

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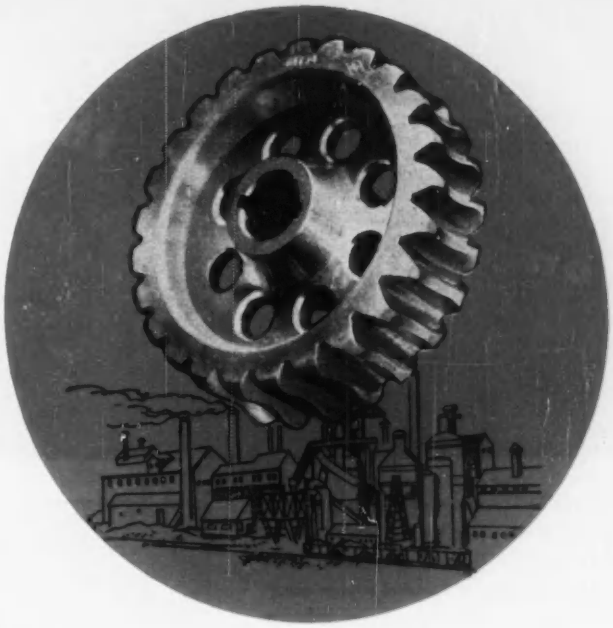

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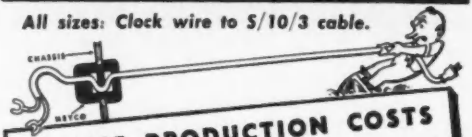

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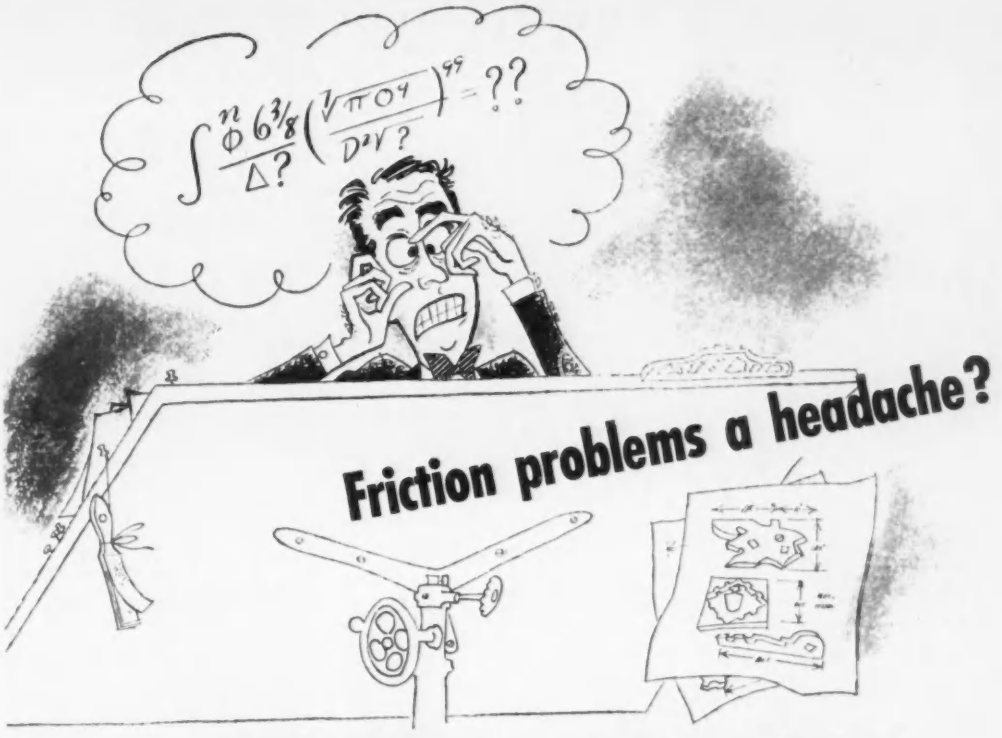

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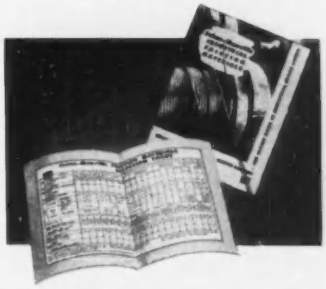

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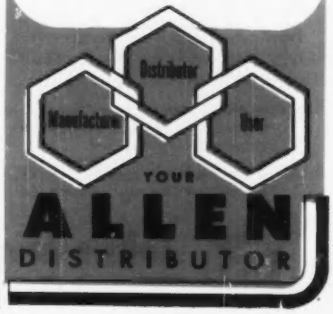

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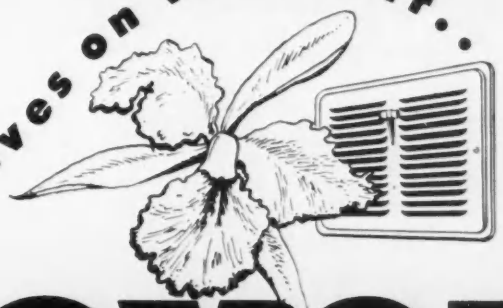

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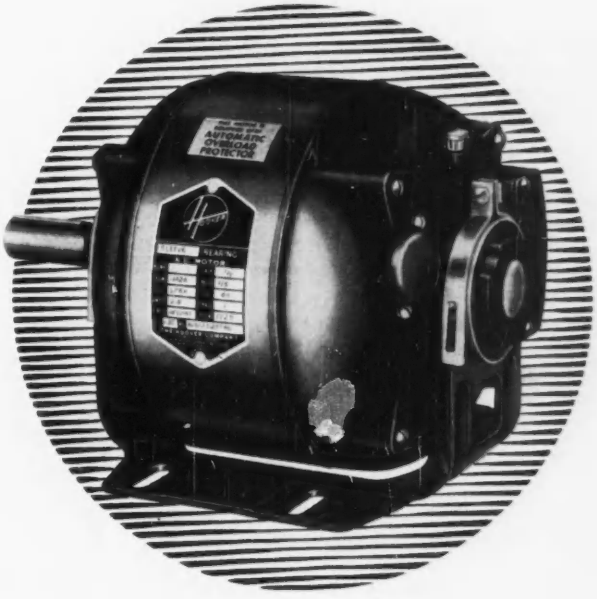

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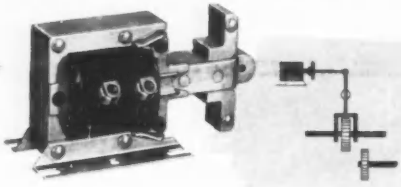
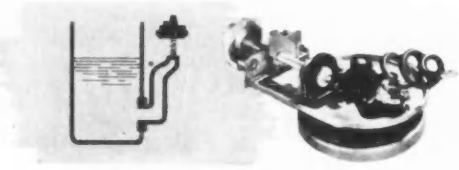
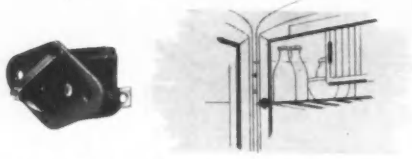






Custom-made components at production-line prices. Isn't that what *you* want? Then look to Soreng for quality electrical specialties—for both defense and civilian production.

Soreng Solenoids, Switches, Terminals and other components are expertly engineered and manufactured to *your specific* application. That means they do a *better* job throughout a *longer* service life. Strict quality control and mass production are your assurance of *dependable* components at *competitive* prices.

So why not see for yourself what Soreng can do for *you*—on both your regular and defense work. Your inquiry will receive prompt attention—without obligation. Please address Dept. N112.

Specialists In Electrical Specialties (SM)

SORENG MANUFACTURING CORPORATION
9555 Eden Ave., Schiller Park, Ill. (Chicago Suburb)
Plants: Schiller Park, Ill. • Fremont, Ohio

CUYAHOGA
Makes Anything from
ROUND or FLAT STEEL!

SPRINGS
WIRE PARTS
WIRE FORMS
STAMPINGS

Every Type Any Style

•

Custombuilt to fit your need

Produced in any quantity... large production runs a specialty.

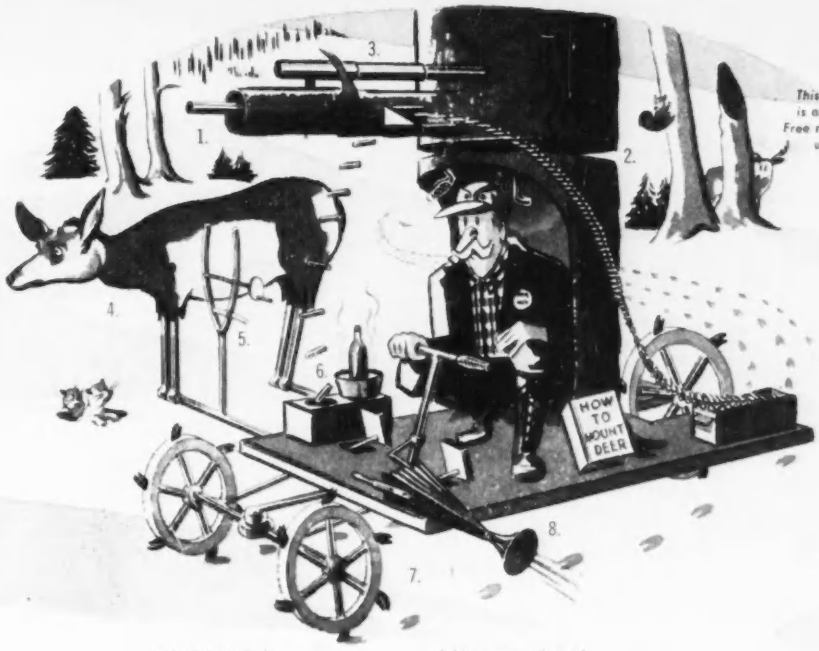
The CUYAHOGA SPRING *Co.*
SUBSIDIARY OF THE BARIUM STEEL CORP
10354 BEREA ROAD • CLEVELAND 2 OHIO

FOUR TYPES OF...
WOVEN BRAKE LINING
COVERING ALL INDUSTRIAL REQUIREMENTS FOR INTERNAL AND EXTERNAL BRAKES

sizes 1 1/2 x 5/32" through 4 x 3/8"
LARGE CAPACITY (10,000 ft. per Day)
LONG EXPERIENCE (since 1927)
SPECIALISTS IN SHORT RUN ORDERS
WE INVITE YOUR INQUIRIES

SOUTHERN FRICTION MATERIALS CO.
CHARLOTTE, N.C., U.S.A.

WILLIAMS
DROP-FORGINGS
ANY SHAPE • ANY MATERIAL • COMPLETE FACILITIES
Write for Free Forging Data Folder . . . Helpful, Informative
J. H. WILLIAMS & CO., "The Drop-Forging People" BUFFALO 7, N.Y.



This advertisement is one of a series. Free reprints available upon request

1. Tree limb conceals rifle.
2. Revolving trunk hides hunter, allows rifle to swivel.
3. Hunter sights deer through periscope.
4. Artificial doe lures game.
5. Calipers measure antler spread.
6. Ejected rifle shells fall into stove, heat rum drink.
7. Wheels leave hoof tracks, confuse deer.
8. Propelling handle also operates bellows which sounds deer mating call.

There once was a hunter named Hank
Who ordered parts for this open-air tank
(An idea that's dear to us all)
We said, "Hank, we're delighted
But please don't feel slighted
If top-rated jobs get first call."

H & H makes brass or copper tubing ranging from ⅛" O.D. to and including 1½" O.D. Also brass and copper LOCKSEAM tubing for aircraft, jeep, truck and stationary engine cooling components.

You will probably never need parts quite like those used in the complicated machine pictured above. But when you go hunting for a source that can provide you with especially-hard-to-fabricate tubular parts for any purpose, think of H & H. From rotating bands for 20 mm. shells to primer tubes—where tolerances must be held to strict Army-Navy specifications—you can depend on H & H to fill the bill. No one is better qualified or more experienced in this field than we. So remember, whatever your requirements, you can look to H & H for the finest in brass or copper tubing. Our defense facilities are at your disposal. Why not call us today?

H&H TUBE AND MANUFACTURING COMPANY
275 North Forman Avenue, Detroit 17
Originators and sole makers of "Metalfs"—the economy tubing

H & H MEANS QUALITY AND SERVICE IN BRASS AND COPPER TUBING

ALUMINUM EXTRUSIONS

fast deliveries

on A, B, C and E Allotments

Any shape that can be contained in a 6 inch circle. Any length up to 40 feet. Send drawings, specifications and data.

Fabrication facilities available!

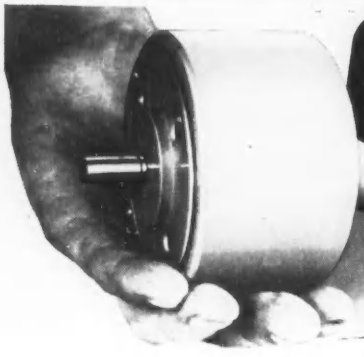
We are equipped for aluminum fabrication from extrusion to finished product.

Address Dept. PE-12

MICHAEL FLYNN MANUFACTURING COMPANY

700 East Godfrey Ave., Philadelphia 24, Pa.

Telephone FIdelity 2-5500



LOW HARMONIC CONTENT PERMANENT MAGNET ALTERNATOR

MODEL N2B

EAD

Originally designed and manufactured to operate into EAD synchronous motors in precision test equipment. Will meet all military specifications—high and low ambient temperature, humidity, altitude, dust, tropicalization, vibration and corrosion.

SPECIFICATIONS

Output 7 volts and 30 cycles, at 1800 RPM. Extremely low harmonic distortion, continuous duty, ball bearings.

This alternator may be modified to meet your individual requirements in 1, 2 or 3 phase for wide voltage ranges at required frequencies.

EASTERN AIR DEVICES, INC.

585 DEAN STREET • BROOKLYN 17, N. Y.

REPLACE COMPLICATED MECHANISMS

WITH *Ledeen* CYLINDERS

Wherever you have to—

PUSH or PULL

LIFT or LOWER

PRESS or SQUEEZE

TILT or TURN

OPEN or CLOSE

Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.

Ledeen **Cylinders are GOOD Cylinders**

Write for Bulletin 500

Ledeen Mfg. Co.

1610 San Pedro

Los Angeles 15, Cal.

For conductivity *plus* strength specify BERYLCO 10 and 50

Need a current-carrying material which is harder than copper, with greater resistance to wear? Investigate Berylco beryllium copper.

Berylco 10 has a conductivity of 45% and a tensile strength as high as 130,000 psi. It also has high elastic, endurance and impact strength . . . good corrosion resistance . . . ability to withstand high temperatures. It has been widely used in circuit breakers, switch gear, and other current-carrying parts. It is available as strip, rod, bar, wire and forgings.

Berylco 50 has even greater conductivity than Berylco 10. It exceeds the requirements of RWMA Class 3 resistance welding alloys. Its hardness and conductivity make it ideal for spot, seam, flash and projection welding dies and electrodes. It is available as rod and bar stock, and as seam welding wheels.

Strength, conductivity, resistance to wear are only a few of the superior properties of Berylco beryllium copper. Find out what Berylco can do for you . . . take advantage of the technical knowledge of the world's largest producer.

Tomorrow's products are planned today — with Berylco beryllium copper

SAMPLE MATERIAL AVAILABLE FOR TESTING PURPOSES

BERYLCO THE **BERYLLIUM** CORPORATION

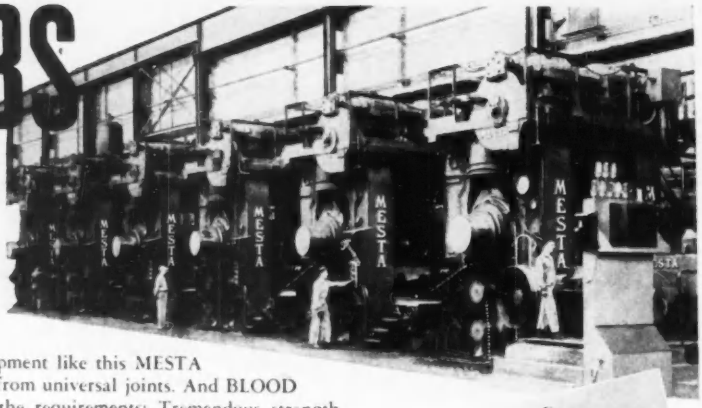
DEPT. 1L, READING 2, PENNSYLVANIA

New York • Springfield, Mass. • Cleveland • Dayton • Detroit • Chicago • Minneapolis • St. Louis • Seattle • San Francisco • Los Angeles

Representatives in principal world-trade centers

BIG JOBS

require big Universal Joints ...built by BLOOD BROTHERS



Heavy-duty steel rolling mill equipment like this MESTA 68" Hot Strip Mill demands a lot from universal joints. And BLOOD BROTHERS Universals meet all the requirements: Tremendous strength, long resistance to wear, and toughness to match heavy shocks or starting loads.

That's why — for big jobs or small — industrial machines, commercial vehicles or agricultural implements, engineers rely on BLOOD BROTHERS job-matched universal joints. They've proved their ability to "stand the gaff" through countless hours of rugged duty.

Before you specify, call on BLOOD BROTHERS for engineering consultation and suggestions.

BLOOD BROTHERS machine co. ALLEGAN, MICHIGAN

Division of Standard Steel Spring Co. • Chicago Office: Great Lakes Spring Division, 7035 West 65th Street

COPPER • MONEL • K-MONEL • BRONZE • CHROME ALLOY • STAINLESS STEEL • GLASS • PLASTICS • ALUMINUM • DRILLED BALLS

Hartford

PRECISION BALLS

Precision balls made for your job. In many materials. Send your specifications to our Engineering Department. Their recommendations will be forwarded to you promptly.

THE HARTFORD STEEL BALL CO.
HARTFORD, CONN.

NEWARK N. J. OFFICE MARKET 2-7169 | EXPORT OFFICE: NEW YORK PHONE PENNSYLVANIA 6-2078 | CHICAGO OFFICE FRANKLIN 1977

2-HS-48

Type "B" Pressure Reducing and Regulating Valve

There's a CASH-ACME Automatic Valve to handle anything that flows—Water, Air, Steam, Gases, Chemicals, Refrigerants, Oil, Gasoline and all other types of liquids.

Laundry Pressing Equipment Manufacturer Specifies CASH-ACME

If you have the problem of finding a lifetime valve that will turn in a consistent performance year after year on the products you manufacture, write CASH-ACME today. We can show you the lifetime installation to handle pressure control without failure and help with the successful operation of your equipment.

CASH ACME SILENT SENTINEL *Automatic Valves*

A. W. CASH VALVE MANUFACTURING CORP.
6662 E. Wabash Avenue
Decatur, Illinois

NEW SOUND LEVEL METER

Improved Design

Accurate · Simple to Use

The new Type 1551-A Sound-Level Meter is very easy to handle. It weighs only 11 pounds, including its battery power supply. It is simple to operate requiring only the switch selection of the appropriate response characteristic, and then the adjustment of a single attenuator switch until the indicating meter stays on scale. The sound level is the sum of the attenuator and meter readings.

When not in use, the microphone folds back into the instrument panel, automatically turning off filament and plate voltages.

Type 1551-A
Sound-Level Meter . . $360.00

- **MEETS ALL STANDARDS** *of the American Standards Association, the A. I. E. E. and the Acoustical Society of America*
- **PORTABLE** — *weighs only 11 pounds, with batteries*
- **SIMPLE TO OPERATE** — *non-technical personnel can make just as accurate measurements as can anyone*
- **COMPLETE BATTERY OPERATION** *from standard batteries, readily available*
- **VERY WIDE RANGE** *of 24 to 140 db; will measure practically any noise level found in industry*
- **EXCELLENT STABILITY** — *improved negative feedback amplifier circuits*
- **NON-DIRECTIONAL CRYSTAL-DIAPHRAGM MICROPHONE**
- **TWO-SPEED INDICATING METER** *for steady or rapidly fluctuating sounds*
- **EXCELLENT ACCURACY** — *frequency response curves within current A.S.A.-specified tolerances; when amplifier sensitivity is standardized absolute accuracy of measurement is within ±1 db for average machinery noises*
- **INTERNAL CALIBRATING CIRCUIT** — *sensitivity can be standardized at any time from any 115-volt a-c line*
- **WIDE FREQUENCY RESPONSE** *of amplifier and panel meter — 20 cycles to 20 kilocycles*
- **LOW TEMPERATURE & HUMIDITY EFFECTS** — *readings independent of both over normal room conditions (within 1 db)*
- **READILY USED WITH ACCESSORY INSTRUMENTS** *such as graphic-level recorders, frequency and wave analyzers, magnetic-tape recorders*
- **MANY ACCESSORIES AVAILABLE** *for special applications; included are special microphones for high fidelity measurements, for reproducible standards and for use at end of long cable.*

STROBOSCOPES · VARIACS · SOUND-LEVEL METERS
VIBRATION METERS · IMPEDANCE BRIDGES
SIGNAL GENERATORS · OSCILLATORS
WAVE ANALYZERS · DISTORTION METERS
IMPEDANCE STANDARDS · VACUUM-TUBE
VOLTMETERS · FREQUENCY STANDARDS
BROADCAST MONITORS · PARTS AND ACCESSORIES

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

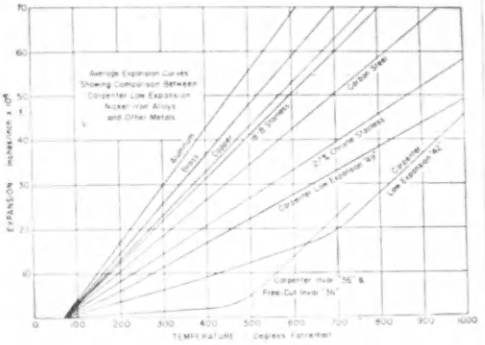
90 West Street NEW YORK 6 · 920 S. Michigan Ave. CHICAGO 5 · 1000 N. Seward St. LOS ANGELES 38

Since 1915 — Designers and Manufacturers of Electronic Test Equipment

An alloy with practically no thermal expansion up to 400°F

Note in the graph how the low thermal expansion rate of Carpenter Invar "36" compares with other metals. The free-machining alloy, Carpenter Free-Cut Invar "36", has the same low expansion characteristics and simplifies production of machined parts.

Where the operation of precision instruments or machines is affected by temperature variations, the low expansion of this alloy helps to insure constant accuracy. Another important use is in automatic on-and-off controls, such as thermostats. These controls are operated by the difference between invar's low expansion rate and that of a high expansion metal.


Average Expansion Curves Showing Comparison Between Carpenter Low Expansion Nickel-Iron Alloys and Other Metals
Aluminum
Brass or Copper
18-8 Stainless
Carpenter Low Expansion "42"
Carpenter Low Expansion "42" Controlled Expansion Alloy
Carpenter Invar "36" & Free-Cut Invar "36"
EXPANSION - INCHES PER 100 FT.
TEMPERATURE - Degrees Fahrenheit

For detailed engineering data on the Carpenter Invar "36" alloys, write for a copy of the Carpenter Low Expansion Alloy book. It contains 23 pages of data on expansion and mechanical properties, physical constants, etc.

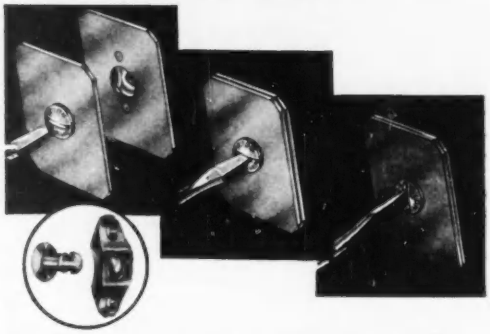
THE CARPENTER STEEL COMPANY
117 W. Bern Street, Reading, Pa.
Export Department:
Carpenter Steel Co., Rdg., Pa.
"CARSTEELCO"

THE CARPENTER STEEL CO., Reading, Pa.
Please send a copy of your Low Expansion Alloy Book.

NAME _____ TITLE _____
(Please Print)
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

For Parts that must be TAKEN OFF—PUT BACK—BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN
Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

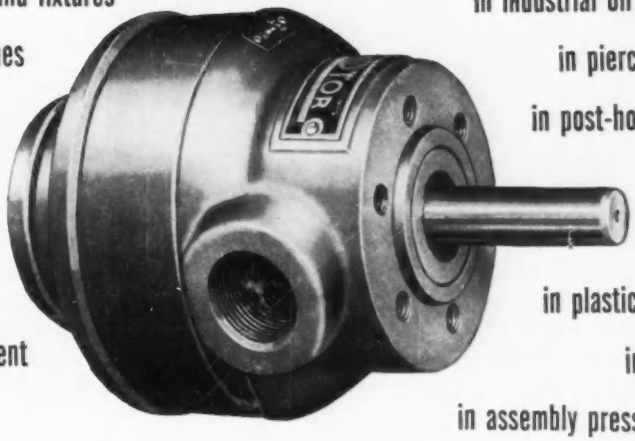
TYPICAL APPLICATIONS: INSPECTION PLATES • COWLING • ELECTRICAL PANELS • CABINETS • DUCTWORK

Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

LION FASTENERS, INC.
300 Main St., Honeoye Falls, N. Y.

PERFORMANCE* is the pay-off!

in machine tools and fixtures
in die-casting machines
in elevators
in punch presses
in baling presses
in clamping fixtures
in testing equipment
in steering devices
in straightening presses
in material-handling equipment



in industrial oil burners
in piercing presses
in post-hole diggers
in plastic presses
in conveyors
in assembly presses

GEROTOR hydraulic pumps

* Pressures up to 1200 p.s.i. continuous, 1500 intermittent. Deliveries from .4 to 40 g.p.m.

GEROTOR MAY CORPORATION • BALTIMORE 3, MARYLAND

The largest commercially available equipment for shake testing according to military specifications is now in service at Sperry Gyroscope Company. Developed by Calidyne to deliver a force output of 2500 pounds at frequencies up to 500 cycles per second, this electrodynamic shaker, with its associated power supply and control system, is the latest addition to Calidyne's complete line of equipment for vibration studies.

Further original Calidyne developments in the field of vibration investigation include other electro-dynamic shakers, vibration pick-ups, couplers, vibration standards, vibration meters, and calibrators for accelerometers and vibration pick-ups. Each of these was produced to satisfy a recognized need in vibration research and the advanced thinking they demonstrate has earned their extensive use in diverse fields of engineering.

When you need sure knowledge of vibration and its effects, you need Calidyne apparatus. Write for your free copy of data sheet EBG-5112.

THE CALIDYNE COMPANY

SALES REPRESENTATIVES IN

NEW YORK, N. Y.
CHICAGO, ILLINOIS
FLORIDA
WASHINGTON, D. C.
PHILADELPHIA, PENNA.
DALLAS, TEXAS

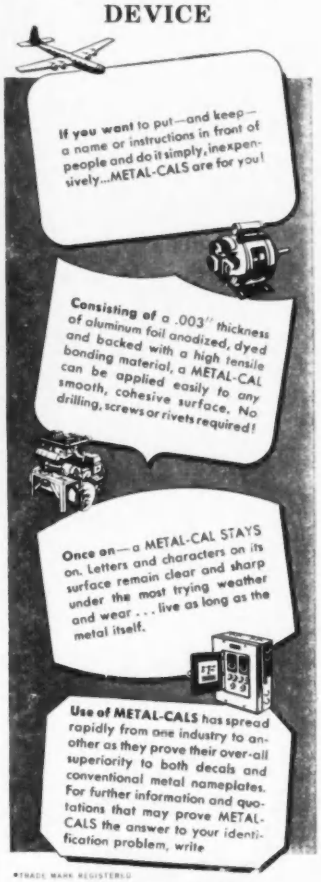
751 MAIN STREET WINCHESTER, MASSACHUSETTS

MINNEAPOLIS, MINN. HOLLYWOOD, CAL. CLEVELAND, OHIO PORTLAND, OREGON

GET BOTH ECONOMY AND LONG LIFE WITH

Metal-Cal*

THE PERMANENT, SELF-ADHESIVE IDENTIFICATION DEVICE


If you want to put—and keep—a name or instructions in front of people and do it simply, inexpensively—METAL-CALS are for you!
Consisting of a .003" thickness of aluminum foil anodized, dyed and backed with a high tensile bonding material, a METAL-CAL can be applied easily to any smooth, cohesive surface. No drilling, screws or rivets required!
Once on—a METAL-CAL STAYS on. Letters and characters on its surface remain clear and sharp under the most trying weather and wear . . . live as long as the metal itself.
Use of METAL-CALS has spread rapidly from one industry to another as they prove their over-all superiority to both decals and conventional metal nameplates. For further information and quotations that may prove METAL-CALS the answer to your identification problem, write

*TRADE MARK REGISTERED

Metal-Cal DIVISION

C & H SUPPLY CO.

Main Office & Plant
Dept. H-2 Boeing Field, Seattle 8, Washington

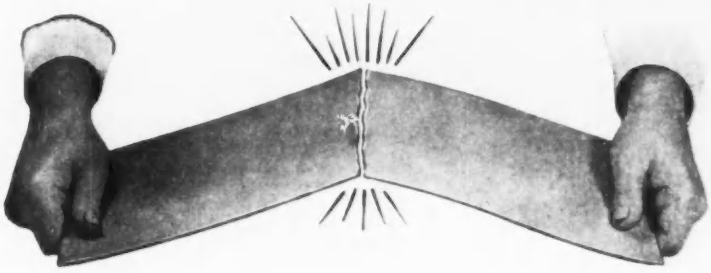
Sales Office
Wichita, Kas.

Sales Office & Plant
Los Angeles, Calif.

NOW IT'S FLEXIBLE!

BEFORE CURING, DUROID 600 *is flexible but not dimensionally stable.*

NOW IT'S BRITTLE!



AFTER CURING, DUROID 600 *is snap-finger brittle but, immersed in hot or cold water, it has better dimensional stability than laminated phenolic.*

This Fiberloy was created to meet the need for a material with controlled dimensional stability, for spacers in a unique oil filter. Scrap reclamation permitted low-cost fabrication. It shows, again, that Rogers can do unusual things with materials to make engineering dreams come true.

THE DUROIDS are special formulations developed to provide specific mechanical and chemical characteristics. They blanket the range of materials properties from laminated phenolic, down through the vulcanized fibres, to paperboards.

OTHER FIBERLOYS by Rogers include special purpose impact phenolics, in bulk or sheet form for molding, and special purpose laminates.

"HERE'S ROGERS AND ITS FIBERLOYS" is an entertaining booklet that will help you decide if the FIBERLOYS have a place in your products. Please write for it to Dept. L. Rogers Corporation, Manchester, Connecticut.

Better Parts for Better Products

ROGERS
CORPORATION
Established in 1832

if

your product calls for **trouble-free power transmission** it calls for . . . . .

Perkins *custom-made* Gears

PERKINS MAKES TO CUSTOMERS' SPECIFICATIONS IN ALL MATERIALS, METALLIC AND NON-METALLIC: *bevel gears, ratchets, ground thread worms, spiral gears, worm gears, helical gears, spur gears with shaved or ground teeth.*

Perkins
Machine & Gear
company
west springfield
massachusetts

SILICONE "O" RINGS OFFER UNIQUE DESIGN POSSIBILITIES

Because of the inherent stability of silicone rubber, Arrowhead "O" rings molded of this remarkable new material provide a long-lasting seal under conditions far beyond the limits of ordinary rubbers. For example, they remain flexible at -150° F.; withstand indefinitely, exposure to temperatures of 500° F. and over. They offer excellent resistance to oxidation, to many oils, acids, alkalies and a variety of chemicals. The ideally inert characteristic of these seals is demonstrated by their astonishing resistance to aging, even at abnormally high temperatures. At normal temperatures they last *indefinitely*. For superior performance under severe conditions, consider silicone rubber. Arrowhead's *silicone specialists* will welcome your inquiry.

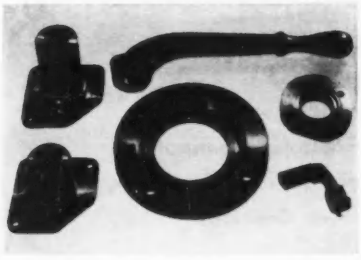
Write **FOR ENGINEERING DATA**

Free to Engineers—two valuable new publications on silicone rubber and "O" rings. Contain complete technical and descriptive data, including typical applications.

ARROWHEAD RUBBER CO.
Division of
National Motor Bearing Co., Inc.
DOWNEY (Los Angeles County) CALIF.

"O" RINGS ♦ SILICONES ♦ AIRTRON-DUCTS

So again the choice is: GRAY IRON



Specify gray iron for smaller operating parts, too, like these components of the torque control pictured above.

MAKE IT BETTER WITH GRAY IRON

Second largest industry in the metal-working field

BECAUSE GRAY IRON DOES THE JOB AT LOWER COST, the designer specified gray iron castings for this torque control housing. He knows you can't beat gray iron for ready machinability at a specified pressure strength level.

GRAY IRON GIVES YOU ALL THESE ADDED PRODUCTION ADVANTAGES: Castability, rigidity, low notch sensitivity, wear-, heat- and corrosion resistance, durability, vibration absorption, wide strength range.

SO SPECIFY GRAY IRON when you need a part that must meet many structural and functional requirements—with economy. We know gray iron will satisfactorily serve your needs.

SCRAP IS NEEDED FOR DEFENSE—KEEP IT MOVING!

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

and Bush Finned Tubing is finned for efficiency

If heat transfer enters into the functioning of your product . . . or your manufacturing processes . . . finned tubing will do it better, quicker and more economically. And Bush Finned Tubing will do it *best* . . .

Because Bush mechanically expanded tube-to-fin bond creates maximum heat transfer at lowest cost.

Because Bush exclusive spacing fingers create exactly the right amount of air turbulence . . . too little turbulence decreases heat transfer efficiency . . . too much turbulence increases static loss and requires larger fan motors. Bush turbulence is *engineered* to perfection.

Because Bush spacing fingers are interlocked to insure permanent coil rigidity which guarantees long life and minimum service.

Bush Finned Tubing is available in aluminum, steel and copper in a full range of sizes and spacings. For complete information address Bush Manufacturing Company, West Hartford 10, Connecticut.

Buy the Best-and the Best is

BUSH

HEAT TRANSFER PRODUCTS

Recent Developments in PLASTICS and RUBBER

New materials and their characteristics, processes and techniques, and applications developed since the war are reviewed in a 32-page report which appeared in the April 1947 issue of *Product Engineering*.

This valuable reference for design engineers summarizes working data on

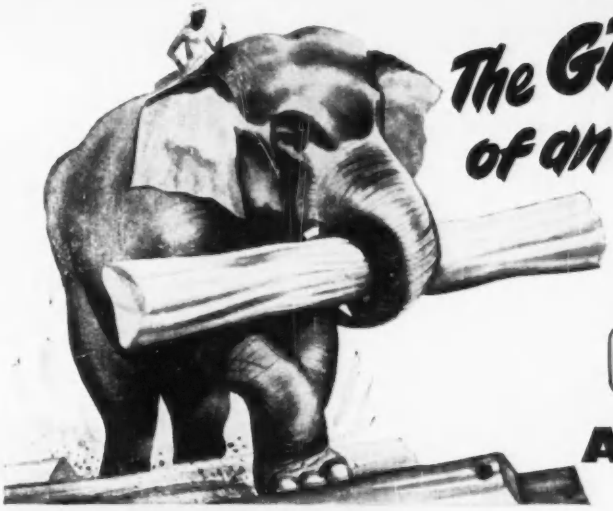
Polytetrafluoroethylene
Modified Styrenes
Polyethylene
Vinyl Plastics
Plastics-Synthetic Rubber Combinations
Synthetic Rubber
Nylon
Silicones
Cellulosic Plastics
Thermoplastic Laminates
Honeycomb-Sandwich Structures
Protective Coatings

Reprints of this article in pamphlet form available at 25¢ each from

Readers' Service Department

PRODUCT ENGINEERING

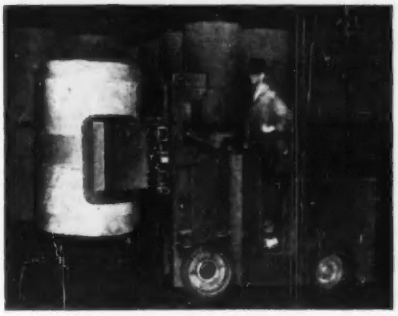
330 West 42nd Street, New York 18, N. Y.



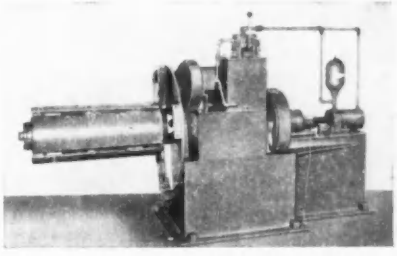
The GRIP of an ELEPHANT

with a

10 CUBIC INCH GREER ACCUMULATOR



This lift truck holds heavy paper rolls between its jaws with the grip of an elephant, thanks to a 10 cubic inch Greer Accumulator. There is no chance of the roll slipping because the accumulator automatically compensates for any hydraulic fluid leakage or pressure loss.



Steel coils on this pay-off roll are held firmly in place during uncoiling by hydraulic pressure stored in a one gallon Greer Accumulator. A pressure switch eliminates the necessity for continuous pumping during the extended holding operation, saving power and pump wear.

Greer Hydro-pneumatic Accumulators are revolutionizing the design of materials handling and production equipment. Cumbersome, complicated, expensive devices for holding and chucking are being replaced with simple, efficient hydraulic units and Greer Accumulators.

A Greer Accumulator consists of a gas filled synthetic bag inside a steel chamber which stores hydraulic fluid pumped into it against pressure in the bag. This energy can be released as needed for restoring pressure loss due to fluid leakage in the system, as an auxiliary source of power for peak loads, and for many other functions described in our new Bulletin 301.

Greer Bulletin 301 is packed with ideas showing how to reduce the size, complexity, and operating cost of equipment with Greer Accumulators by utilizing energy ordinarily wasted during prolonged holding cycles or during intermittent machine operations. Send for your copy today.

GREER ACCUMULATORS

U. S. PATENTS UNDER CLEAR LICENSES

GREER HYDRAULICS, INC.

438 EIGHTEENTH STREET • BROOKLYN 15, NEW YORK

Sales Representatives in Principal Cities • District Office: 437 So. Dearborn St., Chicago 5

Manufacturers of Hydraulic Accumulators • High Pressure Hydraulic Components

Here's how **ELECTRO TEC**

miniature slip ring and commutator assemblies

-solve TOUGH DESIGN PROBLEMS

- 6 INSULATED CONTACT RINGS
- RING WIDTH .030"
- BARRIER WIDTH .015"
- RING DIAMETER .045"
- WEIGHT 5.5 GRAINS (1/80 OUNCE)
- RINGS 60-70 BRINELL FINE SILVER
- TARNISH RESISTANT, FRICTION MINIMIZING SURFACE DEPOSITS
- 1000 VOLT HI-POT BETWEEN RINGS
- COLOR CODED LEADS

PROBLEM: ULTRA MINIATURIZATION — Design and mass produce an extremely miniaturized slip ring assembly. Reduce diameter of rings to absolute minimum to lessen torque friction. Maintain micro-tolerances; eliminate accumulated errors common to "assembled" slip rings.

SOLUTION: ELECTRO TEC EXCLUSIVE* METHOD of unitized, one piece construction provided a prompt, economical solution to this problem. Final design was even smaller than was originally specified and tolerances were held to closer limits.

Same Exclusive* One-Piece Construction Used in All Electro Tec Assemblies

Diameter of Electro Tec assemblies range from .045" to 24" cylindrical or flat. Cross sections of the rings may range from .005" to .060" or more. Rings are polished to a jewel-like finish . . . can be held to four micro-inches or better. Regardless of size, the same exclusive Electro Tec manufacturing technique is used to guarantee precise concentricity, higher dielectric strength, longer life and closer tolerances.

WRITE FOR LITERATURE!

A completely illustrated, four page folder contains full information on Electro Tec Miniature Slip Rings and Commutators. Describes the Exclusive* method of construction that has made Electro Tec the leading supplier to America's major instrument manufacturers. Send for your free copy today on company letterhead.

*PATENTS PENDING

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Uniform "proofing" for bakeries assured by Multi-Purpose THERMOSTAT

3 THERMOSWITCH thermostats control air in Anets Rack "Proof" Box. Thermostat (a) controls air temperature, thermostat (c) with wick acts as humidity control, and thermostat (b), set at 75 F, is wired in series with thermostat (c) to prevent moisture injection with resultant condensation and flooding when starting cold box.

Proper control of the "proof" box is a very important factor in commercial baking. These boxes "proof," or raise, yeast-type doughs by means of warm, humid air that is kept at a pre-determined temperature and humidity. This air must not only be held consistently to requirements, but must also be controlled in such a way that condensation is prevented when box is turned on.

To accomplish this, Anetsberger Brothers, makers of Anets proof boxes, chose Fenwal THERMOSWITCH thermostats. In successful operation on these boxes for more than ten years, these thermostats maintain conditioned air with laboratory accuracy. Operating on 24 volts A.C., they regulate temperature and humidity of air with such precision that bakeries can depend on uniform "proofing."

Low cost, compact, precise THERMOSWITCH thermostats solve many types of control problems. Easy to install, easy to maintain, they operate on a unique principle that permits effective control of many variables where heat is a factor. Their activating control element is the single-metal shell that expands or contracts instantaneously with temperature changes, making or breaking the totally enclosed electrical contacts.

Find out now how Fenwal THERMOSWITCH units can help you. Mail coupon today.

Fenwal

THERMOSWITCH

The Precision, Multi-Purpose, Thermostat Control

SENSITIVE . . . but only to heat

FREE! **Get this bulletin . . . see what Fenwal THERMOSWITCH Units can do for you.**

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FENWAL, INCORPORATED, 212 Pleasant St., Ashland, Mass.
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Company .....

Street .....

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I am chiefly interested in the applications checked:

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- ☐ Cooling
- ☐ Humidity Control or Detection
- ☐ Alarm (over-temperature, under-temperature)
- ☐ Vapor Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) .....

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PUMPS • VALVES • TRANSMISSIONS • REMOTE CONTROLS

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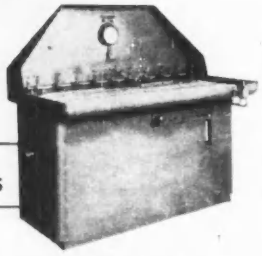
ENGINEERING FABRICATING



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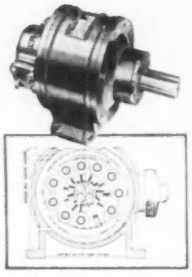
Let *SUPERDRAULIC* Engineers do the job for you

• Our specialized engineering and manufacturing knowledge is available to you for the designing and production of your power units and test stands. Superdraulic designs take into consideration every requirement and limitation of your job. Units can be furnished complete in every detail including motors, pumps, valves, reservoirs, etc.

FAMOUS SUPERDRAULIC HIGH PRESSURE PUMP

Develops up to 60 H.P. at 5,000 P.S.I. Let us quote on your requirements.



Superdraulic CORPORATION

14256 WYOMING AVE. • DETROIT 4, MICH.

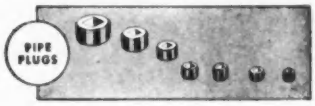
TOUREK

BALL JOINTS • PIPE PLUGS AND QUALITY SCREW MACHINE PRODUCTS

Tourek's quality Ball Joints meet exacting requirements. Simplified design, improved performance, and lower costs result from specifying Tourek Ball Joints . . . the only recognized standard. Large stocks assure prompt delivery.

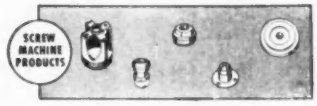
Tourek's precision countersunk steel pipe plugs are accurate, high strength, and economical – resulting in the highest quality at costs which are competitive on old style plugs.

Stock sizes, available with National Pipe or Dry-Seal threads are: ⅛", ¼", ⅜", ½" and 1". Also available on special order in alloy steels, aluminum or brass in sizes up to 2⅝" diameter.



Modern high speed single and 6-spindle automatics — together with complete auxiliary equipment, including grinding and brazing — plus 30 years' experience, assure you "The Best in Quality Screw Machine Products."

Your requirements, up to 2⅝", are made with utmost precision, and with prompt-est delivery possible.



LITERATURE

Comprehensive data on any or all Tourek products sent promptly upon request . . . write for yours now. J. J. TOUREK MFG. CO. 4701 W. 16th St., Chicago 50, Ill.

TOUREK

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IT'S TIME . . .

again . . .

TO WAKE UP SCRAPPY!

Scrap's getting scarce again . . . compared to the amounts we need . . . and it's up to *all* of us to *help* produce enough steel.

107,000,000 tons of steel is the present rate of production in 1951 . . . 119,500,000 tons is expected in 1952.

Last year, 1950, we produced 97,800,000 tons.

All that extra steel—enough to take care of *both* military and civilian needs—calls for *more scrap iron and steel.*

Scrap Inventories Are Alarmingly Low

While steel mills are producing at a greater rate than ever, scrap inventories have dwindled. Many mills are operating on a hand-to-mouth basis with shut-downs threatened unless we furnish more scrap.

We *do* have the scrap. It's everywhere, not just in the form of *production* scrap—the "leavings" of machining, normally turned over to scrap dealers . . . but also in the form of *idle* metal: obsolete machines and tools, no-longer-usable jigs and fixtures, gears, chains, pulleys, valves, pipe, abandoned steel structures, etc.

We must have this *idle* metal to keep the furnaces running.

Please cooperate. Set up a Scrap Salvage Program in your plant—*now.* For a complete plan on "how to do it", write for booklet "Top Management: Your Program for Emergency Scrap Recovery". Address Advertising Council, 25 W. 45 Street, New York 19, N. Y.

Why Do We Need *Scrap?*

Steel is made half from pig iron, half from scrap. With production on the increase, more scrap must be purchased. And it's up to you to "dig it out" and sell it.

NON-FERROUS SCRAP IS NEEDED, TOO!

This advertisement is a contribution, in the national interest, by

McGRAW-HILL PUBLISHING COMPANY, INC.

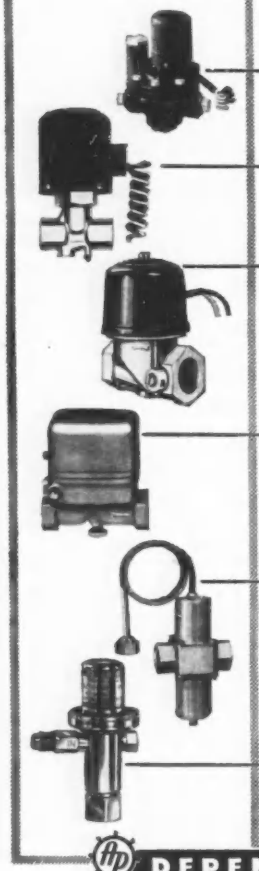
330 WEST 42nd STREET NEW YORK 18, N. Y.

A PUBLIC SERVICE PROJECT THE ADVERTISING COUNCIL

WHEN YOU NEED DEPENDABLE CONTROL VALVES

. . . SPECIFY

Control valves for air, gases, liquids or refrigerants must be completely dependable — particularly where automatic functioning of product or process is required. A-P offers years of experience, unexcelled engineering facilities, plus precision manufacturing methods and meticulous quality control to back up its guarantee of DEPENDABILITY in Service. A recognized leader in the field of flow-control, A-P offers a wide range of types and sizes — pressure, temperature or electrically controlled.



REMOTE CONTROL
SOLENOID VALVES

Heavy-duty, pilot-operated, industrial-type solenoid valves for water. Non-overheating moisture-proof coil, easily removable strainer and valve seat. Capacity to 3000 gal. per hr.

Multi-purpose solenoid valve. Handles air, water, or non-corrosive liquids and gases. Capacity up to 600 gal. per hr.

Rugged, long-life solenoid valve for low pressure air or gas control. Positive opening and seal-off, even with voltage or pressure variations. No sticking or gumming. Quiet, no-hum operation due to unique design.

SILENT, POSITIVE-OPERATION
THERMO-ELECTRIC GAS VALVES

Where inexpensive, reliable automatic temperature control is required, this thermo-electric gas valve has many advantages. Its diaphragm-operated power element is absolutely silent in operation. Positive, tight seal-off; full opening, full closing on 30-second cycle. Large capacity; compact size; dependable functioning.

PRESSURE-REGULATED
WATER VALVES

A-P water valves will control water flow in response to pressure changes. Unique valve design permits trouble-free operation even in very dirty water. Operating pressure adjustable from 65 to 300 p.s.i. Maximum water pressure 150 p.s.i. 3/8", 1/2", and 3/4" sizes; capacities from 3 to 42 gal. per min.

PRESSURE OR TEMPERATURE CONTROLLED
EXPANSION OR THROTTLING VALVES

Designed primarily for refrigerant control, A-P expansion valves are adaptable to many applications where automatic control of temperatures or pressures is required. If you have a problem involving the control of liquid or gas flow in response to pressure or temperature changes, a standard, low-cost A-P expansion valve may provide an immediate answer.

DEPENDABLE Controls

For Air • Liquids • Gases • Refrigerants

A-P CONTROLS CORPORATION

(formerly Automatic Products Company)

1601 N. 32nd St., Milwaukee 45, Wis. • In Canada: A-P Controls Corporation Ltd., Cookeville, Ont.

What makes one man worth $40,000 — another only $4,000? . . . this book tells . . .

HOW TO CULTIVATE YOUR TOP EXECUTIVE QUALITIES . . .

—and win success faster in the upper brackets

TOP EXECUTIVES aren't born. They're made. Self-made mostly. Though they rise along different routes, the steps to their success are similar. They follow a definite course of action . . . and arrive at the top **as planned**. Now, here is a practical, inspiring book which brings you this amazing success formula. It outlines a specific, detailed plan for cultivating the qualities which mark the top-flight business leader today—illuminating each point with intimate, on-the-job studies of currently outstanding executives.

DEVELOPING YOUR EXECUTIVE ABILITY

By **Howard Smith**, Personnel Consultant, Noted Lecturer, and Instructor with Dale Carnegie Institute. 225 pages 5½ x 8, **$3.50.**

This book provides a blueprint that shows how you can win executive success. Showing that executive genius is not a quality one is born with, but the result of concentrated effort along the right lines, the book tells how to direct the same efforts and thinking which you already expend daily toward the definite goal of improving your executive ability. Packed with helpful pointers it tells how the up-and-coming executive can make the most of his capabilities, grow in executive stature, and rapidly qualify for the upper bracket responsibilities and rewards.

Some facts this book gives you:

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- 3 best methods for improving personality
- 11 ways to put over your personality
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- 11 aids for making decisions
- 11 steps for handling worries
- how to budget time most efficiently
- 12 tested techniques for giving instructions
- how to talk to groups effectively
- how to handle responsibility
- how to give yourself publicity

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Send me Smith's Developing Your Executive Ability for 10 days' examination on approval. In 10 days I will send $3.50, plus few cents postage, or return book postpaid. (Postage paid on cash orders.)

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Graduate engineer, experienced in handling engineering problems on small mass-produced items.

Must work closely with manufacturing supervision and sales. To carry responsibility for engineering decisions on process and performance of a specialized electrical component.

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P-2502, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

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Aeronautical Engineer—GS-12, $7040 per annum—duties: Head of evaluation branch, power plants division of the engineering dept. Directs specialized investigations of the performance of rocket engines, rocket power plants, or their components.

General Engineer—GS-11, $5940 per annum—duties: Head of facilities branch, power plants div., engineering department. The facilities branch makes plans, procures and installs equipment for new testing facilities and for modifications of existing facilities. The work covers all phases from initial planning and layout to actual installations.

Aeronautical Engineer—GS-9, $5060 per annum—duties: Project engineer in the evaluation branch, power plants div., of the engineering department. Conducts specialized investigations of the performance of liquid propellant rocket engines, rocket power plants & their components. Devises special test procedures, make theoretical analyses, and prepare evaluation reports on rocket engines or components.

General Engineer—GS-9, $5060 per annum—duties: Project engineer in facilities branch, engineering dept. The facilities branch makes plans, procures and installs equipment for new testing facilities. The work covers all phases from initial planning and layout of actual installation.

Aeronautical Engineer — GS-9, $5060, per annum—duties: Project engineer in the evaluation branch, power plants div., of the engineering dept. Conducts specialized investigations of the performance of liquid propellants rocket engines, rocket power plants, and their components.

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Applicants should submit standard form 57, application for federal employment, which is available at any post office, and forward to

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INDUSTRIAL RELATIONS DEPARTMENT,
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LAKE DENMARK, DOVER, NEW JERSEY.

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Write directly to *Mr. M. H. Arms*, Chief Engineer.

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Fort Monmouth, N. J.

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Mr. R. C. Cibella
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For design of respiratory and medical equipment, with at least five years experience in design. Give references, age, experience, and educational background.

P-2472, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

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To sell a volume line of staple articles of steel and brass with continuous repeats. Direct to R. R., utilities, O. E. M. etc. State lines, type trade and territory.

RW-2630, Product Engineering
330 W. 42 St., New York 18, N. Y.

REPLIES: Box No.'s: Address to office nearest you
NEW YORK: 330 W. 42nd St., (36)
CHICAGO: 520 N. Michigan Ave., (11)
SAN FRANCISCO: 68 Post St., (4)

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HELP WANTED: The Taylor-Winfield Corporation, 1962 Mahoning Avenue, N. W., Warren, Ohio, a leading electric resistance welder and electronic control manufacturer, has five openings for Design Engineers in their Mechanical Engineering Department. These are permanent positions, provided men selected prove they have the necessary skill and ability. Men with resistance welding design experience are preferred. However, recent mechanical engineering graduates will be given careful consideration. The work is 100% board work, involving the design of electric resistance welder machines and component parts such as jigs and fixtures used in conjunction with this type equipment. Experience or training in electromechanical machinery would be a definite asset in meeting the job requirements. Interested applicants should write the Personnel Department stating age, education, experience, salary expected and other pertinent data.

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SALARIED POSITIONS $2,500 to $35,000. We offer the original personal employment service (established 41 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered, present position protected. Ask for particulars. R. W. Bixby, Inc., 268 Main Bldg., Buffalo 2, N. Y.

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CONSULT: Z. B. POLACHEK,
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Factory Management & Main.
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Food Engineering
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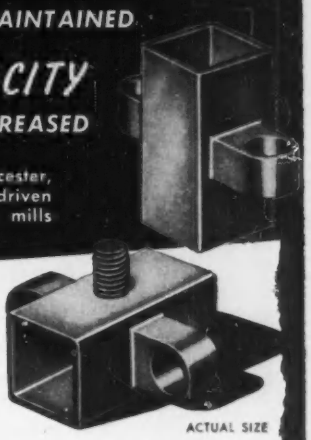

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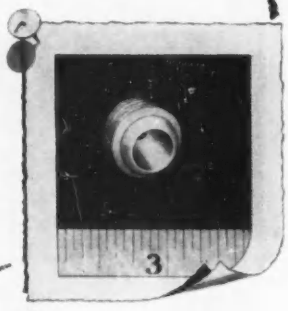

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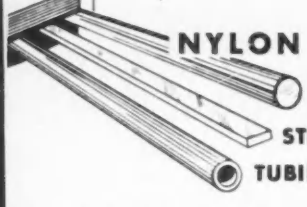

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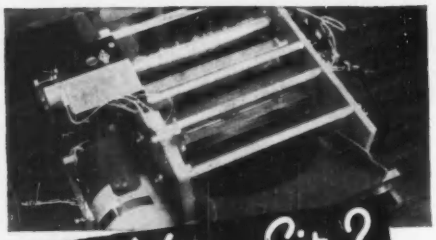

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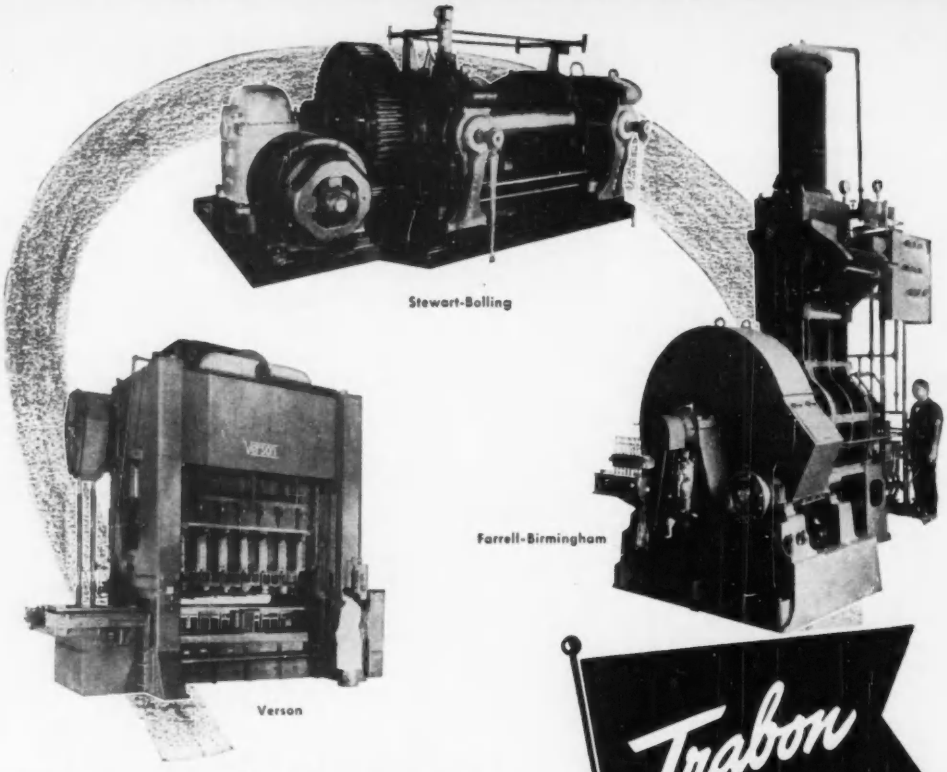

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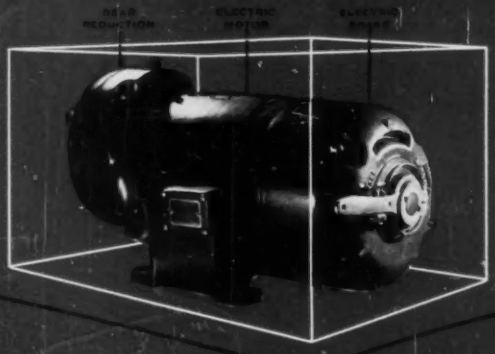

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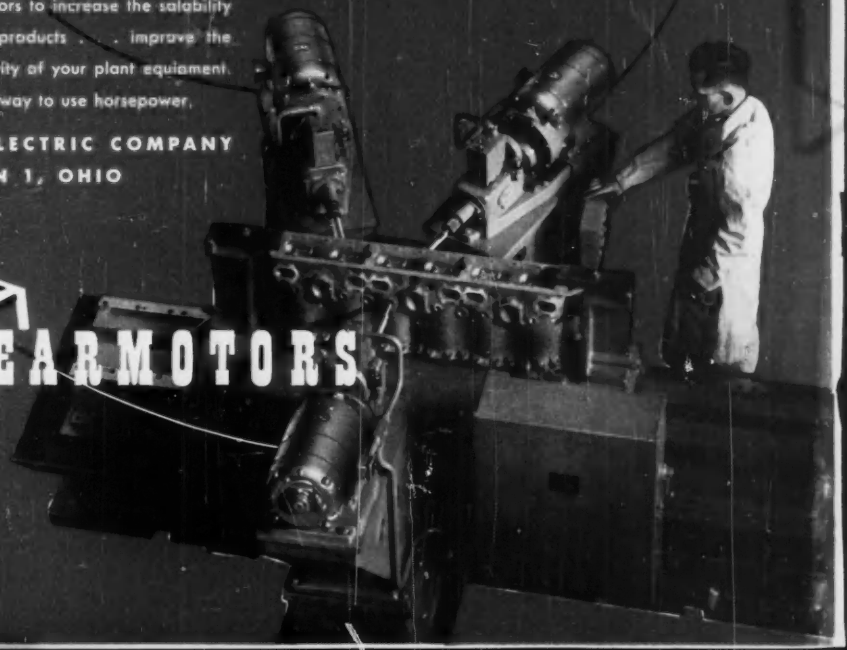

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